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ELECTRICITY AND RAILWAY WORKING.

NINE MONTH'S RAILWAY ACCIDENTS.

THE returns recently issued by the Board of Trade for the nine months ending the 30th September of the present year, show that, judged by the number of persons killed and injured, from accidents to trains, rolling stock, permanent way, &c., the casualties for the period are more favourable than were those for the corresponding nine months of the previous year. The number of killed reaches 16, viz., 11 passengers and 5 servants of companies. The number of injured 401 passengers and 77 servants, being a total of 478. For the corresponding period we find the figures—32 killed and 538 injured; the proportions of passengers to servants being practically the same. The result, so far, is therefore satisfactory, and we venture to express the hope that no mishap of a serious character may arise during the remaining portion of the year to militate against these figures.

Satisfactory, however, as is the sum total of the casualties when compared with that for the previous year, one cannot but wish the numbers were reduced; and, moreover, one cannot but think, when scanning the causes producing these results, or contributory thereto, that such might be the case. Thus, for instance, we notice that during the period in question, the chief contribution to this loss of, or injury to life, is to be traced to collisions between trains. 25 collisions occurred between passenger trains or parts of passenger trains, resulting in the death of one servant, and injury to 111 passengers and 9 servants. 37 collisions occurred between passenger trains and goods or mineral trains, &c., by which 6 passengers and 3 servants were killed, and 192 passengers and 27 servants injured. These are the two main causes of the casualty list; and we fancy it will occur to others, as well as to ourselves, to ask why should the preponderency so strongly exist with the latter class of accident? We know it is impossibe to avoid mixed traffic, but we also know that—at all events as regards our chief lines of railway—where the traffic is thus mixed it is worked under the "block" system, and collisions should be few and far between. The data furnished with the returns now issued is not sufficiently detailed to admit of our analysing the causes; we hope, however, to return to the subject with the issue of the report on the year's work, when the details will be such as to enable us to produce more complete information. From reviews of isolated reports which have from time to time appeared in our columns, we do not think we shall be far wrong in looking to junctions, station yards, and similar points as lucrative in those results which all, more or less, deprecate. It is not exactly a loose system of working, but it is open to grave consideration whether it is not capable of improvement. The block system provides for trains being kept apart by a certain space, but that space, taken as between the tail end of one train and the engine of a following train, may be a very small one, and, practically, at many points consists of the thickness of the blade of the signal arm. It is needless to say this admits of no overrunning; and doubtless if drivers were in all cases careful to observe the signals, less casualties would have to be recorded. Nor does a stop signal protecting the work of a station—crossing or shunting trains—admit of any latitude in the speed of approaching trains. There must be no overruning the point at which the signal says, "You must not pass here." This is quite right so far as the rules and regulations for working railways go; and if there were no mishaps on the part of drivers, no overrunning of signals, if signals were always obeyed, all would be well. But if this cannot be secured, we would like to ask if it is not possible to obtain some remedy by the establishment of a neutral space, a space beyond one end of which no station working shall proceed, and beyond the other end of which no train shall approach so long as the signal is against it. We are inclined to think that if this course is open to adoption it would be found to meet in a great measure the difficulty which now exists, and to which is due in no small measure many of the casualties referred to.

We are aware that to adopt such a course is open to the objection that it is a concession in favour of those who disregard the rules, and are not sufficiently careful of their running. But even if this were so and the result were the reduction of accidents, the advantages would far outweigh any objection on this score.

Another difficulty which we think likely to present itself would be that such a course would involve not only the adoption of more signals, but the extension of the distance at which the signals have to be worked. The increase of signals is to be deprecated, but if they are unavoidable we can only submit. With regard to the increased distance at which signals might have to be worked, we think electricity might be found an efficient aid, and we have much pleasure in directing attention to the subject. We believe there is a great opening and a large field for a reliable railway signal worked by electricity; and we believe, further, that there should be no great difficulty in the production of such. We are satisfied, if those who are acquainted with what is required would give the subject that attention of which it is worthy, success would attend their efforts. Electricity is already a powerful aid in railway working, and if applied to the operation of distant and, possibly, other signals also, its services would be largely augmented, for, at the present moment it is often impossible to select the most suitable positions for such signals, for the reason that the distance at which they can be worked is limited. With electricity as the motor there would be very little limitation. We are

aware of attempts having been made to partially operate signals by means of the electric current, but that which we desire to see is signals operated entirely by its aid, not merely put on, or taken off, as the case may be—the opposite action being effected mechanically—but that the double action of the signal should be so effected. Such a signal would become invaluable upon railways. It could be placed at any point; in the most conspicuous position; and, practically, at any distance.

We commend these two suggestions to the consideration of our readers, and especially to those interested in railway working, believing that their adoption would prove both a means of reducing casualties upon railways and extending still further the field for the useful employment of that branch of science to which our columns are devoted.

WE learn that the motion brought forward by the London editor of *Industries* to restrict the conditions under which the representatives of the technical press shall be admitted to the meetings of the Society of Telegraph Engineers and Electricians was not carried, but referred to the Editing Committee of that body. A number of considerations must be dealt with, for this is a question which should not be discussed in a flippant way nor decided without grave thought. During the period of the Society's existence has anything been published in electrical journals which would have been best suppressed? We cannot recall any circumstances which would lead us to that manner of thinking, but, on the contrary, we believe that the Society has been materially benefited, especially during the past five years or so, by the publication, *in extenso*, of good papers and the discussions thereon. Even members can only be present in limited numbers to hear papers read and listen to the arguments for and against the views advocated by the writers, and the absentees, who must always form the large majority, naturally look to the weekly electrical press to supply that information which could only come to them months afterwards through the medium of the Society's journal. It is not merely the members, however, who must be considered, but also those gentlemen connected with the electrical industries who may, by becoming interested in noting the Society's fortnightly proceedings, desire to become associated therewith, and we believe that at no period since the Society sprang into being has there been a greater influx of new blood than during the time mentioned above. It becomes a question, then, for the Editing Committee to decide whether it will be advantageous to the Society or the reverse to restrict the privileges which the technical press has hitherto enjoyed. Of this we are quite certain, that more members than one of the Editing Committee have personally felt the benefits of immediate publication of the Society's proceedings. So far as we and our estimable contemporaries are concerned the matter is not of great weight, for our existence does not depend, in the least, upon the diffusion of the words of wisdom which emanate from Great George Street; we should all go on in the same humdrum way and fill our pages with papers which, if not always of such vast importance would, at least, offer greater variety. Mr. Kapp's motion has not one redeeming feature to recommend it, and on the strength of the private and confidential circular letters which, we are informed, he sent to the members of the Council, excepting to one gentleman whose exclusion can only be accounted for by reasons which he had the courage to express at the meeting—it should be condemned. We can only come to the conclusion that since Mr. Kapp's famous experiment of putting his head in the place where the armature of a dynamo should be his lines of thought have become distorted and taken a lead in the wrong direction. The introduction of new blood into any Society which is apt, through lapse of time, to become fossilized, is at all periods desirable, but on the other hand a little blood-letting has been known to act advantageously in bringing a feverish and excitable nature to think more calmly and reasonably.

THE United States Senate Chamber, in the capitol at Washington, is lighted by the Westinghouse converter system. Mr. Edward H. Johnson, the president of the Edison Electric Light Company; Mr. Geo. Maynard, an electrician in the same city; and Mr. J. E. Powell, the electric light plant inspector to the Treasury Department, are endeavouring by all the means in their power to show that the employment of this high tension method not only imperils human life, but threatens the total destruction of the building from fire. The experiments of Mr. Harold P. Brown are quoted to show that while 1,000 volts difference of potential with continuous currents may be treated with impunity, 200 volts alternating will cause instantaneous death. Mr. Johnson goes so far as to say that the only object in using the high tension current is to effect a small saving in copper conductors, but that the cost of operating is thereby increased *in perpetuo* by reason of the loss of current in the converters. It is evident that the arguments of these gentlemen are all advanced from interested motives, and although there are certain elements of truth in their assertions, there are several statements which are absolutely untrue, especially that of Mr. Johnson's relative to the 1,000 volts continuous current. At one of the South Kensington Exhibitions a few years ago a man was killed by a continuous current machine which showed a difference of potential of 500 volts only between the points touched.

THE solution of the problem of how best to apply electricity for the happy dispatch of criminals in New York was undertaken some weeks ago by the Medico-Legal Society, which appointed a committee of four gentlemen to report upon the most suitable method of putting the new law into practice. We do not know whether much interest is manifest in this country on the subject, but at all events the following extract from the report will cause some amusement amongst our own fraternity:—"There are several points requiring thoughtful consideration in the application of death currents to man, which we now proceed to lay before you. The average resistance of the human body is about 2,500 ohms. The most of this resistance is in the skin. It is evident, therefore, that the larger the surface of the electrode applied to the body, the greater will be the resistance. It is also a fact that the density of the current depends upon the superficial area of the electrode. A pole of small diameter will hence meet with less resistance, the passing current will be more intense, and the resulting current strength will be greater than when an electrode of large sectional area is applied." Dr. Stone will doubtless be able to

appreciate to the fullest extent these remarkable conclusions of our American Cousins.

Apropos of the very funny description of the method of manufacturing "Swinburne" incandescent lamps which appeared in our last issue, we may mention that the late Robert Sabine manufactured some excellent filaments from the fibres of dock leaves. We are not aware that anybody else ever tried this material, but it might be worth while to repeat Mr. Sabine's experiments.

IN a leaderette published in our issue of November 9th last, we alluded to Latimer Clark being the originator of marking G.P. wires, &c., in a manner similar to that adopted by the Standard Cable Company. We were quite sure of it, so far as our knowledge and experience extended, having had practical acquaintance with Clark's plan and knowing that it was patented. During the last few evenings we have had some occasion to dive into antique patents and to our surprise have come across the following: "1853—December 8th. No. 2,846.—Henley, William Thomas.—Improvements in Electric Telegraphs. In order that any particular wire may be known throughout its length on opening the ground, a tape or yarn is introduced (from which all the wires are numbered) into the rope, thus enabling any particular wire to be found." At that time Henley had been making a number of gutta-percha cables for the Magnetic and other companies. The plan is obvious and apparently taken from the Admiralty plan of marking. We are not sure that it was ever adopted in practice by him, but the method has been suggested over and over again. The following also came at the same time under our observation: "1854—June 21st. No. 1,357.—Physick, Henry Vernon.—2nd Claim. Methods of distinguishing the separate wires from one another in submarine and subterranean cables. A strand of hemp, or other suitable material, is wound spirally (helically ?) on one or more of the wires. When several cables are laid together, this method can be applied to distinguish them from one another. A difference in size, colour or material of the strands may be made, or the gutta-percha may be marked or embossed." In this case the idea is very general and we are not aware whether it was ever carried out, but in Clark's patent the plan is specific and has been actually employed in several cables, and what is more to the purpose, has been found to be of great practical use.

AT the time of the introduction of double working or "duplex" telegraphy by Stearns in 1871, we think some discussion took place as to the origin of the word. We believe it was conceded to the Americans, but we find it in an older patent than that of Stearns, "1856—July 25. No. 1,775.—Baggs, Isham." (What a name!) Amongst the improvements, &c., he specifically mentions, "In a duplex telegraph instrument," &c. So Isham Baggs ought to have the concession.

CAN any of our readers give an explanation of the following facts sent to the *Standard* of Monday by a firm of solicitors who are renters of a telephone from the United Telephone Company:—During the night of Friday last a great noise was heard by the housekeeper, who sleeps on the premises, and in the morning the gong of the telephone bell was found on the floor. This was put back in its place on Saturday morning, but at about 11 a.m., when no one was in the telephone room, another great commotion was heard, and, on entering the room, a strong smell of burning was noticed. It was then perceived that the baize on the telephone board was singed, and that the telephone was out of order. The firm sent for one of the company's assistants, who, on opening the bell-box, found that the spring and metal rings had been fused, and the whole contents of the box were charred. He then commenced to disconnect the wires, and for that purpose used a pair of pliers. While thus employed a flame burst from the wire he was cutting, sparks flew across the room, and his thumb and finger were much blackened. He immediately dropped the pliers, and stated that he believed if he had not let go at once he would have been killed. He could give no explanation, and, as yet, we have not received any from the company, though two of their men have been here. The firm thinks it is a matter which may interest fire insurance companies, for, unquestionably, fire was generated, as the effect of it was plain. The only explanation which suggests itself is that the telephone wire by some means had come into contact with an electric lighting wire. As might be expected, the writers look upon this incident as a strong argument in favour of placing electric light wires underground, and evidently some such rules as we publish this week, which are in force in the City of New York, will sooner or later become necessary in the metropolis. As everybody knows, these little accidents have for some years past been of common occurrence in America, much to the disgust of telephone men, who certainly have much reason for complaint. An instance of this is given in the *Standard* of yesterday, where Mr. M. D. Scott refers to the destruction, by fire, of the telegraph operating room of the Canadian Pacific Railway Company, in Montreal, about six months ago, by the crossing of electric light and telegragh wires. Mr. T. D. Lockwood, the well-known trans-Atlantic electrician, thus bewails the telephonists' hard lot:—"Now, the position of the telephone man is simply this: That he was on hand with his circuits and doing business; his current neither hurts nor offends anybody. Another man comes along with a current which spoils the business of the telephone man; but with a comparatively small number of lines. The second man for many reasons must necessarily employ a metallic circuit, from pole to pole of his dynamo. The first man naturally thinks and says: 'I was here first; I am supplying the public; my presence hurts no one's business; I have necessarily a great number of wires; but the electric light man comes in, he uses a machine with few sections in his commutator, when by using more he would have a steadier current; he has to have a metallic circuit in any event; he agrees with me that a properly constructed metallic circuit would materially improve the situation, and he has comparatively few wires. Where he is first I certainly will not go. His proximity to my wires ruins my business; I therefore have every reason in holding that it is his business and duty to run his wires properly, to employ a machine which develops a steady current, and to keep his wires a suitable distance from existing telephone circuits; and so the courts have more than once decided.' No artificial appliance can take the place of a proper intervening distance between the two classes of wires." Unfortunately, no information is given as to the whereabouts of the solicitors' offices. It is almost certain, however, that they are in the West End of London.

THE GEYER-BRISTOL METER FOR DIRECT AND ALTERNATING CURRENTS.*

By Prof. WILLIAM E. GEYER.

IN the meter about to be described we make use of the heating effect of the current. Electric measuring instruments depending on this heat effect are not new, as in the Cardew voltmeter we have an application which has found much favour. Here the current of greater or less strength traverses a long thin wire, heats it more or less, and the direct expansion is a measure of the current, and indirectly of electromotive force.

In an ammeter it is necessary to keep down the resistance, and I therefore doubt whether direct expansion can be usefully applied for this purpose ; for the actual elongation of a bar of metal, even when raised through a considerable range of temperature, is very small. In the familiar compound bar we have a case where a very small actual elongation produces a relatively very great lateral displacement.

I think I shall best be able to explain to you our meter, by recalling to your minds this old device. In the simplest compound bar two strips of metal which have different coefficients of expansion are securely soldered flatwise along their entire length. Brass and steel are metals frequently employed. On heating, the brass expands more than the steel, and, in consequence, the bar bends, becoming convex on the side of the brass. When such a bar is heated by the passage of the electric current, it will deflect, and this deflection may be made a measure of the current. The disadvantage of such an instrument would be that atmospheric changes of temperature would also cause deflection, so that troublesome corrections would have to be introduced.

In our meter we also use a sort of compound bar, but eliminate at once the effect of the surrounding temperature by taking metals whose coefficients of expansion are the same or sensibly equal ; in fact we take the same metal. Our first form of construction was as follows :—A wire of German silver is laid upon a strip of German silver of considerably greater cross-section and radiating surface. The wire and strip are soldered together at one end, separated for the remainder of the length by a film of mica, then tied together at frequent intervals with silk or other insulating material, and suitably supported or clamped at the unsoldered end. If now a current, either continuous or alternating, is allowed to enter the strip at one end, it runs along its length, there enters the wire, and leaves the instrument at the other end of the wire.

For a given current the wire, on account of its greater resistance, and also on account of its smaller radiating surface, becomes hotter than the strip. In consequence of the difference of expansion the bar bends, becoming convex on the side of the smaller conductor. This combination we call a differential bar.

We would also state that inasmuch as the results obtained by the use of this instrument are due to the excess of the heating effect of an electric current upon one portion of the bar, or its equivalent, over the other, it is in a measure immaterial to the principle of the invention whether the current which produces the differences in temperature be caused to heat the two parts directly or indirectly. For example, the more expansible part, in lieu of being included directly in the circuit, may be arranged in close proximity to, but insulated from, a wire or conductor which is heated by the current. The other part or element may be in the circuit or not, but in either case formed or arranged to be less sensibly heated than the other.

It will readily be seen, however, that to heat one or both of the parts of the device in this manner would be clearly equivalent to connecting them both in series in an electric circuit. Unlike the case where magnetic action is employed, the force here available is very considerable, so that to make the instrument self-recording, it is only necessary to attach an inking device to the free end and move in front of it a properly ruled chart. In this respect we have no difficulty whatever. My associate, Prof. Bristol, who has done the larger part of the work, has, since our first experiments, very much simplified the method of constructing the differential bar, and the one used in the instrument exhibited was made by placing a flat strip of German silver between a pair of dies which make alternate depressions and elevations along the length of the bar ; the wire, insulated with asbestos, was then slipped in the tube-like space thus formed, and the whole pressed between plates provided with grooves of the proper depth so as to leave the wire to one side of the centre line and at the same time to insure its being held firmly by the little bridges along the length of the bar. Since the bars can be constructed essentially by these two machine operations it is evident that they may be readily reproduced and at very small cost.

We have determined experimentally the best relation between the cross section of the strip and wire to give maximum deflection. We believe the instrument could readily be made integrating, but doubt the desirability of doing so. Our reason for this could probably not be better expressed than in the words of an eminent engineer, Mr. Charles E. Emery, in his paper on "Heating cities by steam," before the Franklin Institute, which we quote as follows :—

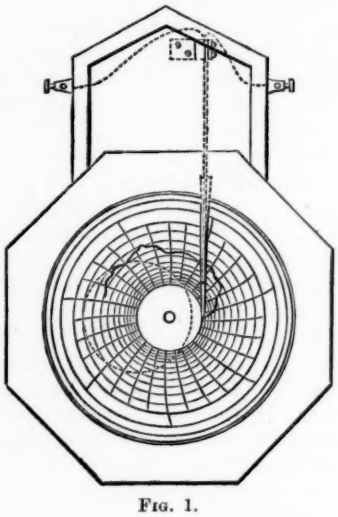

FIG. 1.

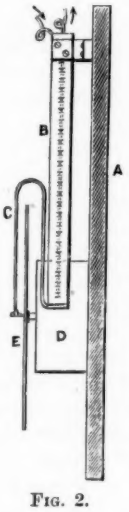

FIG. 2.

"It was at first considered unfortunate that a reliable meter could not be obtained, which, like a water meter would show by differences of reading the quantity of steam used for the interval between observations

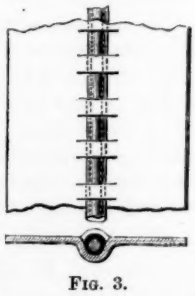

FIG. 3.

directly without calculation, and without expense of maintaining a time register at each location, and of integrating the charts afterward. This system, however, proved a blessing in disguise. The greatest difficulty in settling with consumers lies in the fact that employés waste the steam. This is particularly the case during

* Read before the American Institute of Electrical Engineers, New York, November 13th, 1888.

the heating season, when steam for various uses is left on continuously during nights and Sundays, thus increasing the time of consumption from, say, 60 hours a week to 168 hours. In many cases, too, the rate of consumption keeps uniform during the night as well as during the day, so that it is an easy matter to more than double the bills. The consumers at first naturally lay the blame to the steam of the steam company, but the meter charts have been the means of enabling the company to satisfy consumers when, and to what extent, the increased bills were due to mismanagement on their premises."

Substitute electricity for steam and the reasoning will apply perfectly to our case.

In the accompanying illustrations, fig. 1 is a general view of the differential bar, mounted in a case with inker and recording dial. Fig. 2 is a side view of the important parts, the case being removed.

The following letters refer to the different parts :—

A, supporting framework ; B, differential bar ; C, inking pointer attached to bar ; D, clockwork moving dial ; E, revolving dial for receiving record.

Fig. 3 shows a small portion of the bar and a cross section on an enlarged scale.

SMITHFIELD CLUB CATTLE SHOW.

AT the Cattle Show held last week at the Agricultural Hall, Islington, some of the leading makers exhibited engines which, while suitable to perform the usual duties of an agricultural engine, such as thrashing or sawing, during the day, are equally adapted for driving a dynamo for electric illumination at night. For example, Messrs. Robey and Co., of Lincoln, exhibit a horizontal steam-engine, of 10 H.P. nominal, fitted with their patent Trip expansion gear, which secures the greatest economy of fuel and perfect governing under varying loads. It is also fitted with their patent electric regulator, by means of which the engine adapts its speed to the number of lamps in circuit. Messrs. John Fowler & Co., of Leeds, showed an 8½-inch single cylinder horizontal high-pressure engine, fitted with automatic expansion gear (Hartnell's patent, 1883), by means of which the load can be suddenly thrown off without materially affecting the speed of the engine. This makes the engine specially suitable for electric light installations, and similar work in which great regularity in running is necessary. The cut-off extends from $\frac{1}{10}$th to $\frac{7}{10}$ths of the stroke. The same firm had also a compound semi-portable engine, specially constructed for electric lighting, fitted with Hartnell's patent automatic expansion gear on both cylinders. As usually constructed, engines of this type have automatic gear only on the high pressure cylinder ; but it is essential that the automatic gear should act on both cylinders, if the power given off by each cylinder is to be equal under varying loads. This engine is not only economical, but extremely well governed. It is incapable of exceeding by more than one or two per cent. its mean speed when the load is suddenly removed, and will not fall below the mean speed by a greater amount when the whole load is suddenly thrown on. In practice a small fraction of one per cent. variation of speed at once begins to alter the degree of expansion, a result quite unattainable in ordinary governing, but which is absolutely necessary in electric light engines. Samples of Tatham's patent lead-covered cables and wire were exhibited by Messrs. John Fowler & Co., who are the sole manufacturers for Europe and the Colonies of these cables, which have been found in practice to be very suitable for underground work of all kinds and have been favourably spoken of in our columns on former occasions.

Electric Lighting in Austria.—The Vienna correspondent of the *Daily Chronicle* telegraphs that Marienbad, the well known Bohemian watering-place, will, like Gastein, be lighted by electricity next summer.

ELECTRIC LIGHT EXTENSIONS AT OLYMPIA.

THE National Agricultural Hall at Kensington has now been open nearly two years, and during that period there have naturally been many alterations, developments, and improvements to meet the ever-varying needs of this gigantic place of entertainment. This has been notably the experience with respect to the electric light, which necessarily plays an important part in the various "shows" that are organised. At the outset the installation provided 54 Brush arc lamps, in nine sets of six each, overhanging the centre of the great hall, several hundred incandescent lamps to illuminate the galleries, refreshment and other rooms, corridors and offices, four arc lamps at and over the main entrance, and two in the engine and boiler rooms. As time went on even this extensive provision was found insufficient for the immense area to be covered, and considerable additions have been made, and are still being made. The Brush arc lamps remain as originally fixed, but to these 60 have been added 65 Gülcher arc lamps suspended under and over the galleries. When first introduced these were hung over the arena, extra light being then required, and the fittings remain so that at any moment they can be replaced in that position. During exhibitions this is not necessary, and they are required where they are now placed, but should the whole arena be again occupied by the Hippodrome or similar entertainment, and the movable amphitheatre be re-erected, they would then be transferred. Four of these lamps were put up in the grounds during the outdoor entertainments connected with the Irish Exhibition, but at present the grounds are not in use, and the four lamps are utilised inside. In like manner the glow lamps have been increased, and now number at least 1,000. Of these 100 were fixed in the gardens during the Irish Exhibition, and about 40 in the Old Irish Market, which remains as an attractive part of the present Exhibition. The minor hall, which measures 104 feet by 52 feet, is fitted with 200 incandescent lights, the banqueting hall and the theatre are similarly provided permanently. But in connection with the Winter Exhibition or Christmas Fair there are specially temporary demands for glow lamps. We have already mentioned the Irish Market. On the opposite side of the grand hall there has been erected a Turkish Bazaar. This is decorated in Oriental fashion, and to impart the proper soft, dim, warm light a number of glow lamps have been suspended in quaint coloured lanterns, one or two only being left naked in the smoking saloon, where a somewhat brighter light is required. The effect is striking and pleasing. Suspended from the ceiling are strange-looking balloon birds and fish, and other creatures, and it is probable that to add to their singularity glow lamps will be placed inside them. Some of the lights in the Irish Market are also fixed inside coloured lanterns. One of the principal features of this Exhibition is a monster Christmas tree laden with appropriate articles to be given away. Decorated by these alone the tree looks pretty and bright, but there have now been fitted among the branches about 50 incandescent lamps, which, shining out from amidst the leaves and the trinkets, greatly enhance the picturesqueness of the tree in the evening.

There is yet another and a much more striking application of the electric light to be mentioned. Aloft, on the summit of the building at the western end, and rising to a height of at least 130 feet from the ground, has been constructed an iron lighthouse, surmounted by a lantern of British plate glass. In this lantern is being placed a powerful search light, which will throw frequent flashes over this part of the metropolis for miles round in all directions. It will also be used when necessary, by deflection, to illumine the gardens immediately below. The electric light, it will thus be seen, performs a leading function in all the schemes carried out at Olympia, and this application is likely to be continually extended. From the first—that is, for two years—this installation has worked

without any breakdown or mishap of any kind and in the most satisfactory manner—a fact which speaks well for the contractors and engineers. The building is supplied with gas throughout, but it has never yet been required. If needed, it can be lighted in an instant by electricity. And not only has the installation worked well, but the cost has been considerably less than it would have been for an equal gas illumination. The 125 arc lamps are of 2,000 C.P. each, and the 1,000 incandescent lamps are of 16 C.P.—all combined being equal to 266,000 candles. The plant comprises three marine boilers of 200 H.P., two pairs of Davey-Paxman compound horizontal engines of 200 H.P., and 4 Siemens compound dynamos of 40 units, 600 ampères, and 66 volts at the terminals. The boilers are of mild steel, made by the Steel Company of Scotland, and the plates are among the largest ever rolled, the front plates being solid. Each boiler has 130 tubes and two fire-boxes, and also a donkey-pump at each end, no injectors being used. The engines run at 100 revolutions a minute, driving direct on to the 4 dynamos, and the latter run at 390 revolutions a minute. From these the current for the whole building is obtained. For heating purposes there are also three boilers of the Galloway type, 50 H.P., supplying steam to the whole of the premises at a temperature of 58 degrees, through several miles of piping.

Mr. A. Carey, the original engineer to the company, was succeeded some months ago by Mr. W. Bond (his assistant) who is now carrying on the service with energy, zeal and skill.

TEST OF AN EDISON INCANDESCENT ELECTRIC LIGHTING PLANT.*

By JOHN W. HILL, M. Am. Soc. C.E.

THE writer presumes that all members of the Society are interested in the electric light, if not by direct contact with it as constructors or users, at least from the standpoint of speculation as to its actual efficiency, comparative cost, and general application; and that any practical information (however meagre) in this field will be acceptable for what it is worth.

The writer pretends to no other knowledge of the subject than that gained from a recent test of an isolated plant, in the discharge of his routine duties as an engineer, but he hopes that the facts presented in this paper may induce others of the Society better qualified than himself to analyse the large losses of power and reconcile some of the discrepancies which were developed by the test referred to.

The Union Central Passenger Depôt at Cincinnati is lighted under a contract with local parties by an isolated Edison incandescent electric light plant of a nominal capacity of 800 16-candle-power lamps. The plant, is owned and operated by the local company, which furnishes the necessary attendants, oil and waste for the motive machinery, and makes the lamp renewals; while the Depôt Company owns and operates the boilers, and furnishes the steam to drive the engines. Therefore, to the cost of the light service, as rendered in monthly bills by the owners of the electric light plant, must be added the gross cost of the steam consumed by the engines which operate the dynamos to arrive at the actual cost to the Depôt Company of the light.

The general terms of the contract under which the light is furnished require the owners of the electric plant to develop an illumination the equivalent of gas at the cost of gas; and further provides that, whenever desired, the Depôt Company can make a test for comparative effects and costs of gas and electric light for a period of 16 days, using each illuminant for eight consecutive days of 24 hours each.

* From the Transactions of the American Society of Civil Engineers, June, 1888.

The steady and persistent introduction of arc and incandescent electric lighting, in places where under ordinary conditions the consumption of gas would be large, as railroad stations, hotels, and public buildings, is viewed—to say the least—not with any feeling of pleasure by the gas companies of the large cities, and as a rule the exact information upon the actual cost and the cost relative to gas of incandescent electric lighting, is not as well known to the public or to gas companies as it should be at the present time.

Constructors and operators of electric plants no doubt are possessed of full information upon the efficiency and cost of this mode of illumination, and seem disposed to retain this information as a profound secret in which laymen and the public have no interest.

During the month of October, 1887, the writer, by mutual agreement of the Union Central Passenger Depôt Company and the owners of the Edison incandescent electric lighting plant in the station, made an eight days' test of the plant, in which he was assisted by Prof. Thomas French, jun., of the Cincinnati University, and Mr. Charles E. Jones, electrician, of Cincinnati, the former gentleman making the photometric tests of specimen lamps taken from the fixtures in the building; and the latter furnishing the galvanometer and reading the currents required to maintain the specimen lamps under different conditions of pressure. Mr. Jones also made the necessary measurements to determine the resistance of the specimen lamps cold.

The motive power is obtained from two Buckeye high-speed automatic non-condensing engines, which drive the dynamos through belts and pulleys on a jack shaft, and are each of 50 nominal horse-power, and operating at a speed of 230 to 235 revolutions per minute.

In the following table are given the principal dimensions of the engines and the pulleys:—

	East Engine.	West Engine.
Diameter of steam cylinders ...	10·02 inches	10·03 inches
Stroke of steam pistons	14·00 „	14·00 „
Diameter of piston rod	1·54 „	1·52 „
„ pulley flywheel ...	4·529 feet	4·555 feet
„ driving pulley on jack-shaft	2·497 „	2·516 „
„ driving pulley on jack-shaft	3·332 „	3·365 „
„ dynamo armature pulley	1·1605 „	1·187 „
Ratio speed of dynamo to speed of engine	5·207	5·132

The current generators consist of two Edison dynamos, each of 300 ampères capacity; each being furnished with a commercial ammeter to indicate the current (ampères), and a Howell indicator to note the pressure of the current in volts.

The boilers furnishing the steam, three in number, are of the return tubular variety, and each of the following dimensions:—

Diameter of shells	42 inches
Length of shells	12 feet
Number of tubes	40
Diameter of tubes (outside)	3 inches

Grates, continuous under the three boilers, 43 inches long × 12 feet 7 inches wide.

Gas-house coke is used as fuel for the boilers.

The Edison lamps in continuous service are all of 16 or 32 nominal candle-power, and are distributed through the depôt building, train shed, omnibus court, and storage rooms and stables of the American Express Company.

The test embraced: (*a*) a careful measurement of the performance and cost of operating the boilers; (*b*) the power developed by the driving engines, and the proportion of that power transmitted to the dynamos; (*c*) the power (electromotive force) of the currents generated by the dynamos; (*d*) the lamp service, taken by eight skilled observers, who made hourly rounds of the portion of the building in their respective charge, and noted the time, location, and nominal candle-power of each lamp in service. (In the train shed the lamps

were operated in rows as trains arrived and departed; and these were noted by the number of the row and intervals in service); (*e*) the photometric test of 43 specimen lamps, taken from the fixtures in and about the depôt building and train-shed; (*f*) the test of specimen lamps, simultaneously for brilliancy and current, to estimate the proportion of electrical energy of the dynamos actually realised in the work of the lamps; and (*g*) a weighing of the positive plates of the voltameters; from the transfer of zinc in which the owners of the electric light plant render the monthly bills for lighting the depôt and surrounding premises.

For convenience, the results of the tests are presented under the following heads:

1. Comparative cost of electric light and gas light for equal effects.
2. Illuminating power of electric lamps, with changes in the angle of the filament or loop, and potential of current.
3. Performance of the voltameters and relation of their record to the light actually furnished.
4. Relation of the work of the engines to the work of the dynamos, and relation of the work of the dynamos to the work of the lamps.
5. Notes of explanation of the contents of the tables of observed and calculated data.

1. Comparative Cost of Electric and Gas Light.

The feed water was measured to the boilers in two tight casks, containing at 65 degrees Fahrenheit 880·5 and 869·75 pounds respectively. These were charged alternately from the city mains, and the contents delivered through the feed pump to the boilers. The water record consisted of the number of casks consumed, the time required to exhaust each cask, and the temperature of the water, which also was the temperature of the feed to the boilers.

The coke, weighing 40 pounds to the standard bushel, was measured in uniform charges of 150 pounds, and two charges of 300 pounds were delivered to the firemen at each round, and no other or additional coke was permitted on the boiler room floor until the previous charges were thrown into the furnaces. The quality of the steam was taken with a very sensitive small Fairbanks platform scale, graduated to weigh to two ounces, and a James Green United States Signal Service thermometer.

During the test of 192 hours, or eight consecutive days (6 a.m., October 11th, to 6 a.m., October 19th), there were charged to the boilers the following quantities:

	Pounds.
Coke to start fires	782·75
Pine kindling, taken at one half its weight in coke	244·62
Coke to operate the boilers eight days	36,376·00

There are two batteries of boilers in the station, which are alternated in service every two weeks, whence the average daily consumption of fuel to start fires is 73·384 pounds; and the average daily consumption of fuel, including coke to operate the boilers, 4,620·384 pounds, and a consumption for the month of October of 3,580·8 bushels, costing, at seven cents per bushel, $250.66.

The consumption of water by the boilers, from tank measurements for eight consecutive days, was 32,826·83 gallons, to which should be added 5 per cent. for wetting the ashes, cleaning boilers, and washing the boiler room floor (taken from separate tap), or 1,641·34 gallons, making total consumption for eight days 34,468·17 gallons, or a consumption for the month of 133,564·15 gallons, costing at nine cents per 1,000 gallons, $12.02.

From the bills rendered the Depôt Company by the owners of the electric light plant for 1886, it seems the cost of light for the month of October is 0·08615 of the cost for the whole year, and as the steam, and consequently the cost for fuel and water will be proportional to the illumination furnished, then the cost of these items per annum will be as follows:

$$\text{Coke}..\frac{250{\cdot}66}{0{\cdot}08615} = \$2{,}909.53. \quad \text{Water}..\frac{12{\cdot}02}{0{\cdot}08615} = \$139.53.$$

Add to this the wages of two firemen, at $45 per month each, or per annum $1,080.

Interest on boiler plant and fixtures, valued at $3,000, at 5 per cent., $150.

Depreciation of boiler plant, taken at 10 per cent. of valuation, or $300.

When the total cost of the steam per annum becomes $4,579.11.

From the tabulated statement of the lamp service during the eight days of test, the average illumination for the whole time is shown to have been equivalent to 185·15 lights of 16 actual candle-power each; for which the charge for the interval of time, according to the method of rendering bills for incandescent electric lighting, would have been:

$$\frac{185{\cdot}15 \times 16 \times 192 \times 45}{1{,}000} = \$255.95,$$

and the annual charge:

$$\frac{255{\cdot}95 \times 31}{8 \times 0{\cdot}08615} = \$11{,}512.55.$$

While it is the intention of the owners of the electric plant to make a charge of 45 cents per 1,000 standard candles of illumination, the bills are not based on the amount of light furnished, but on the deposit or transfer of zinc in the zinc voltameters, the assumption being that the zinc deposit, and consequently the average current passing through the voltameters, bears a constant proportion to the total current in the circuit in which the voltameter is placed.

If it were convenient to state the actual amount of light furnished for any given length of time, as a certain hourly average number of 16 or 32 actual candle-power lights, it would be preferable to the present mode of charging for the electric light, but no meter has yet been devised—so far as the writer is aware—which will render an account of the lamps in service, and the average brilliancy (candle-power) of the lamps. If such an apparatus were invented, and could be depended upon to render an account of the lamp service, then its statement for the month (or any other interval of time), would be reduced to an average hourly service in thousand standard candles, and multiplied by the rate per thousand candles, upon which the contract for lighting was based. In this instance the rate is 45 cents per thousand candle-power of effect.

From the tabulated statement of the zinc voltameters the transfer of metal from the positive to the negative plates, for the 192 hours of trial, in the aggregate, was: 21,829 grams, which, according to the formula of the owners of the electric lighting plant, is multiplied by the constant 17, to obtain the corresponding light furnished in thousand standard candles. (The standard candle to be understood as burning at the normal rate of two (2) grains per minute, or 120 grains per hour.) From which the cost of the illumination (exclusive of steam) to the Depôt Company becomes: $C = 21{,}829 \times 17 \times {\cdot}45 = \$167$ for eight days, or $647.09 for the month (October), corresponding to an annual charge of $7,511.20, or a total cost for illumination per annum as follows:—

Electric light company charge	$7,511.20
Cost of furnishing steam to operate the driving engines	4,579.11
	$12,090.31

The present price per 1,000 cubic feet for coal gas in Cincinnati is $1.15, and by photometric test, according to the determinations of Prof. French, has an illuminating power with a consumption of five (5) cubic feet per hour, of 16·94 standard candles, from which a light of 16 candle-powers would represent a consumption of 4·722 cubic feet per hour, and the cost of an illumination the equivalent of that furnished by the electric light for October would be:

$$C = 1{\cdot}15 \times \frac{185{\cdot}15 \times 4{\cdot}722 \times 744}{1{,}000} = \$748.03,$$

and an annual cost, assuming as before that the light for the month of October represents 8·615 per cent. of the light for the whole year of $8,682.91, or a net annual saving over the electric light of $3,407.40, corresponding to an increased cost for electric over gas lighting of 39·24 per cent.

If the electric light was charged for at the rate of 45 cents per thousand standard candles of *actual effect*, as the contract for the lighting really allows, then the cost per annum, including the outlay of the Depôt Company for steam, will be $16,091.66, or $7,408.75 over the cost for coal gas, corresponding to an increased cost of electric over gas lighting for same illuminating effect of 85·33 per cent.

Perhaps it will be more convenient to compare the costs of electric and gas lighting in the following manner :—To the rate of 45 cents per 1,000 candle-power of light furnished by the owners of the lighting plant add the cost (ascertained by trial) of the steam per 1,000 candle-power of light, or :

$$\text{Steam} \quad \ldots \quad \frac{101{\cdot}54 \times 1{,}000}{192 \times 185{\cdot}15 \times 16} \times 100 = 17{\cdot}85 \text{ cents.}$$

Cincinnati gas is shown to have an illuminating power of 16 candles for an hourly consumption of 4·722 cubic feet, and is sold at $1.15 per thousand cubic feet, hence the cost of an illumination, the equivalent of 1,000 standard candles, burning at the normal rate :

$$\frac{4{\cdot}722 \times 1{\cdot}15}{16} \times 100 = 34 \text{ cents.}$$

Bringing the cost together we have—

Per 1,000 candle-power, Edison electric light ... 63 cents.
Per 1,000 candle-power, Cincinnati gaslight ... 34 cents.

The average light service, and the average illuminating power of the electric lamps, was a matter of ocular demonstration, while the measurement of the illumination furnished by means of the zinc voltameters, depends upon the shunting of a small decimal (0·001) of the current in any circuit, through the meter connected in that circuit.

2. Illuminating Power of Electric Lamps, with Changes in the Angle of the Filament and Potential of Current.

Subsequent to the test for cost of electric light, a special investigation was made of three 16, three 32, and one 100 nominal candle-power lamps, selected from the specimen lamps tested by Professor French for brilliancy during the economy trial of the plant.

These lamps were tested simultaneously for strength of current and illuminating power ; the filaments being placed successively in three positions at an angle of 45 degrees, at an angle of 90 degrees and parallel with the plane of the photometer bar. The 100 candle-power lamp was tested in one position only, at an angle of 45 degrees to the plane of the bar.

The tests for brilliancy of the specimen lamps were made with a standard photometer from the American Meter Company, Philadelphia, the bar being graduated to give the candle power of the sample lights when compared with a single candle, burning at the normal rate of two grains of spermaceti wax per minute ; and in order to diminish the ratio of electric to candle light, and keep the observation box over that portion of the scale, where slight differences of illuminating effect could be easily and safely read, two standard candles were burned, while testing the 16 and 32 candle-power lamps, and three candles while testing the 100 candle-power lamp. The standard light was furnished from imported candles, and the initial and final weights of the candles, and time to seconds, during which they were burned, carefully observed, to arrive at the exact rate of consumption of the spermaceti wax. The normal rate of consumption, as is well known, should be 120 grains per hour or two grains per minute, and the photometric observations were corrected to agree with the observed rate at which the sperm was burned for each test.

The galvanometer used in this test was a very perfect instrument, and was connected in the circuit calibrated for location and read by a very skilful observer.

The measured candle-power of the specimen lamps in the following table are the means of the three positions in which the filaments were placed, excepting the 100 candle-power lamp as previously noted.

The potential difference given in the table was taken from the Howell indicator in use with the plant at the station.

Comparison of Lamps for Current.

	Designation of lamps.						No mark.
	B	D	C	F	A	E	
Nominal C.P.	32	32	32	16	16	16	100
Actual C.P.	62·44	30·90	26·16	36·33	21·10	16·36	144·75
Potential, volts	99	99	99	99	99	99	99
Strength of current, ampères.	1·25	1·189	1·310	0·773	0·816	0·694	2·986
Electrical energy in Watts	123·75	117·71	129·69	76·53	80·78	68·71	295·614
Watts, per nominal C.P.	3·867	3·678	4·053	4·783	5·049	4·294	2·956
Watts, per actual C.P.	1·982	3·809	4·300	2·106	3·828	4·199	2·042
Resistance, cold, ohms	143·5	156·0	135·0	239·0	224·0	241·0	Not taken.
Resistance, hot, ohms	79·2	85·3	75·37	128·0	121·3	142·6	33·15

The 16 and 32 C.P. lamps were tested October 22nd, and the 100 C.P. lamp, October 21st, 1887.

Averages.

Nominal C.P.	Actual C.P.	Current ampères.	Watts.		Resistance.	
			Per nominal C.P.	Per actual C.P.	Cold.	Hot.
16	24·597	0·7610	4·709	3·377	234·7	130·63
32	41·166	1·2497	3·866	3·363	144·8	79·36
100	144·75	2·986	2·956	2·042	...	33·15

The resistance in ohms of the lamps hot is expressed as follows :—

Let A = strength of current in ampères,
P = the potential difference in volts, and
O = the resistance in ohms,

then $O = \frac{P}{A}$

The watts or units of electrical energy required to maintain the brilliancy of the lamps is obtained by multiplying the current by the potential, or $W = A \times P$, where W = watts.

In the table of averages it will be noted that the watts per actual candle-power of lamps is practically the same for 16 and 32 candle-power lamps, while for the 100 candle-power lamp, the electric energy per actual candle-power is less than 61 per cent. of the energy required by the smaller or weaker lamps. The relative energy required by the 100 candle-power lamp, agrees with the general assertion of electric light operators that a given illumination costs less with lamps of high than low candle-power. But when we turn to the electrical energy required to maintain the 16 and 32 candle-power lamps, it seems that in this respect there is nothing in favour of the lamps of higher candle-power, and that it costs just twice as much for one 32-candle-power light as for one 16-candle-power light. Of course, the cost of lamp renewals is relatively less when the given illumination is produced with one half the number of 32 candle-power lights, because the latter, while lasting no longer in service, costs less than twice as much as lamps of 16 nominal candle-power. The relative cost being about as 50 to 65.

The (D) 32 candle-power lamp was tested for current and brilliancy for different conditions of potential, with the following results :

Potential.	Ampères.	Candle-power.
99—	1·050	23·94
99	1·189	31·20
99+	1·268	43·89

No test was made of the Howell indicator from which the potential was read, and the exact value of the graduations, above and below the normal position of the index (99 volts), is unknown. But the whole range of the scale was supposed to be from 93 to 105 volts, from which it appears that a slight change in the potential—such a change as frequently takes place in the operation of the plant, even with reasonably constant manipulation

of the resistance box—there is a very great change in the illuminating power and cost of furnishing the light.

The reduction of the resistance reduces the potential and strength of current, and diminishes the power required to drive the dynamos, and prolongs the life of the lamps, but with a loss in the illuminating effect. So long as the illumination is paid for upon the weight of zinc transferred in the voltameters, there may be no serious objection to the variable resistance and potential, and variation in the actual candle-power of the lamps. But should the light be charged for upon the basis of a given average number of lamps of a given average candle-power, for a given number of hours, then it might operate against the interests of the consumer, in that he may be paying for considerably more light than he receives.

An observer of a lamp giving 43 candle-power actual effect could distinguish the reduction, if its power was diminished to 24 candles, but could form no correct conception of the measure of reduction, while the life of the lamp would be greatly prolonged by the change of power, and the cost of producing it diminishes from 20 to 25 per cent.

Referring to the table, a comparison of the currents required to maintain the lamps with constant potential (99 volts), shows that the electrical energy, and consequently the cost, is about the same for weak and strong lights; or while the illuminating power of the lamps steadily diminishes with age (use), the strength of current to maintain its brilliancy is substantially constant.

Indeed, it may be shown by the data of this test that the electrical energy and cost of the light becomes greater with the diminished candle-power, thus:

Nominal candle-power lamps.	Actual candle-power lamps.	Potential volts.	Current amperes.	Electrical energy Watts per actual candle-power.
32 (B)	62·44	99	1·25	1·981
32 (D)	30·16	99	1·31	4·300
16 (F)	36·33	99	0·773	2·106
16 (E)	16·36	99	0·694	4·199

Upon the whole the average current and electrical energy for the tested lamps is substantially the same as for the new lamps of each candle-power, thus:

32 candle-power	lamp (B) new lamp	...1·25	ampères,	123·75 watts.
32 „	lamps average all	...1·2497	„	123·72 „
16 „	lamp (F) new lamp	...0·773	„	76·53 „
16 „	lamps average all	...0·761	„	75·34 „

From which it appears that while the electrical energy and cost of maintaining the brilliancy of the lamp during its life is reasonably constant, the cost of the light furnished is in an increasing ratio; or, in other words, while the lamps are new the cost for a given illumination is but one half of the cost for the same illumination after the lamps have been in service for a few weeks. With gas or kerosene, a given constant consumption of the illuminating material furnishes a constant power of light, while a diminished brilliancy of light is always accompanied by a reduced consumption of material and a corresponding reduction of cost; with the electric light of the Edison incandescent system, while the power of the light steadily diminishes with use, the cost increases in a corresponding ratio.

Of 33 16 (nominal) candle-power lamps tested by Professor French, the average brilliancy, when placed at angle of 45 degrees to the plane of the photometer bar, was	16·99	candle-power.
When placed at angle of 90 degrees to the plane of the bar	14·26	„
And when placed parallel with the bar ...	17·05	„
Of the 10 32 (nominal) candle-power lamps, the average brilliancy, when placed at an angle of 45 degrees to the plane of the photometer bar, was	41·08	„
When placed at an angle of 90 degrees to the plane of the bar	34·13	„
And when placed parallel with the bar ...	40 66	„

The angle of maximum illuminating power for the filament of an electric lamp is supposed to be 45 degrees to the plane of the photometer bar; but from these tests it seems there is very little difference in the average effects of the lamps when the filament is placed parallel with or at an angle of 45 degrees to the bar. But with the filament placed flatwise, or at right angles to the bar, there is a loss of illuminating power from 17 to 18 per cent.

The extreme sensitiveness of the lights to slight changes in the potential, or strength of current, was clearly shown during the special test for brilliancy and current, the power of the light frequently changing from 20 to 30 per cent. while taking an observation. To the writer it seems that this range and rapidity of variation in the brilliancy of the light is a dangerous feature of the incandescent lighting system, especially if the light should be applied to any close work, as reading, writing, drawing, engraving, and similar occupations. For general illumination, the fluctuations of candle-power may not form a serious objection; but the hurtful influence to the eye of a light which is rapidly changing in illuminating power is generally recognised by oculists.

The average illuminating power of the 33 16-nominal-candle-power lamps tested for brilliancy was 16·199 actual candle-power, and for the 10 32-nominal-candle-power lamps, 38·637 actual candle-power. From this it appears that the 16-nominal-candle-power lamps in service during the test of eight days should be increased in the ratio of 1·0124, and the 32 candle-power lamps, 1·2074, for actual illumination furnished.

The general average hourly number of lamps in service were:

Of 16 candle-power lamps	111·961
Of 32 candle-power lamps	29·733

and reducing the 32 nominal candle-power lamps to an equivalent number of 16 candle-power lamps, and increasing both in above ratios, we have as the actual average hourly light service, 185·1516 candle-power lights, costing, as previously stated for an interval of 192 hours, $268.54.

3. PERFORMANCE OF THE VOLTAMETERS.

The voltameters used by the owners of the electric lighting plant to measure the service to the Depôt Company contain two thin zinc plates, attached to the positive and negative poles of the cup; the transfer of the zinc from the positive to the negative plate, for any given length of time, being taken as the difference of weight of the losing plate before and after the interval.

In the following table are given the sums of the losses of zinc between 6 a.m., October 11th, and the same hour, October 19th, for 40 voltameters, divided as follows:

5 6-light meters.
10 25-light meters.
21 50-light meters.
4 100-light meters.

The light mentioned in the designation of the voltameters, means nominal 16 candle-power lights, from which the meter capacity of the electric lighting plant at the Union Depôt is equivalent to 1·730 lamps of 16 candle-power.

WEIGHT OF ZINC PLATES OF VOLTAMETERS.

	Grams.
6 light meters (5):	
Aggregate weight 5 plates, October 11th ...	106·770
„ „ „ 19th ...	106·371
Difference	0·399
25-light metres (10):	
Aggregate weight 10 plates, October 11th ...	761·005
„ „ „ 19th ...	759·118
Difference	1·887
50-light metres (21):	
Aggregate weight 21 plates, October 11th ...	3,068·348
„ „ „ 19th ...	3,055·427
Difference	12·921
100-light meters (4):	
Aggregate weight 4 plates, October 11th ...	1,252·760
„ „ „ 19th ...	1,246·138
Difference	6·622
Total deposit for 192 hours...	21·829

C

During the weighing of the zinc plates of the voltameters, the phenomena (which, as the writer was informed, is not infrequent) developed, of the positive plate gaining instead of losing in weight, showing an apparent reversal of current for meters Nos. 23, 24, 31, 32 and 39. The custom, in cases of this kind, is to take the gain of the plate in weight, as the measure of zinc transferred.

Reducing the total deposit of zinc for eight days to the average transfer per second, we have $\frac{21{\cdot}829}{192 \times 60 \times 60} =$ 0·00003158 gram.; corresponding according to accepted authority in such matters (*), to an average current of $\frac{0{\cdot}00003158}{0{\cdot}0003392} = 0{\cdot}0931$ ampère.

The proportion of current through the shunts of the voltameters is $\frac{1}{1000}$th of the entire current; hence total average current for the time of trial was 93·1 ampères.

The average illumination produced was equivalent to 185·15 lights of 16 candle-power, and from the record of the voltameters the current per 16 candle-power of actual light was:

$$C = \frac{93{\cdot}1}{185{\cdot}15} = 0{\cdot}50283 \text{ ampère.}$$

It is claimed that the current for a nominal 16 candle-power lamp is about 0·75 ampère, and that this is correct for average lamps, when the potential difference is maintained at 99 volts, is shown earlier in this paper, where the average for three specimen 16 candle-power lamps of different ages is 0·761 ampère. But the average illumination of 185·15 16-candle-power lamps, from the observation of the lighting service during the test of eight days, are not average lamps, but actual lights of 16 candle-power each; and by reference to the tabular statement upon page 150, it will be seen that while the average current for 16 candle-power lamps is 0·761 ampère, the average illuminating power of the tested lamps was 24·597 candles; hence by proportion the current for a light of 16 actual candle-power should be $\frac{16 \times 0{\cdot}761}{24{\cdot}597} = 0{\cdot}495$ ampère; or substantially the same current as found from the transfer of zinc in the voltameters.

Adopting the formula employed by the owners of the Edison electric lighting plant, the transfer of zinc in the voltameters was held to represent an illumination during the test of 192 hours of $21{\cdot}829 \times 17 \times 1{,}000 = 371{,}093$ candle-power, or 1,932·77 standard candles per hour; which reduced to lights of 16 candle-power will be 120·736.

The average lamp service, from actual observation, has been stated as 185·15 lights of 16 actual candle-power, from which it seems that the voltameters accounted for only $\frac{120{\cdot}736 \times 100}{185{\cdot}15} = 65{\cdot}21$ per cent. of the actual illumination. But the strength of current per actual candle-power of light furnished, according to the voltameters, was 0·0314 ampère, and the strength of current per actual candle-power of light, from the special test of lamps for brilliancy and current, was for 16 candle-power lights $\frac{3{\cdot}377}{99} = 0{\cdot}0341$ ampère, and for the 32 candle-power lights $\frac{3{\cdot}363}{99} = 0{\cdot}0339$ ampère; or a mean of 0·034 ampère for both; hence the voltameters—upon the assumption that $\frac{1}{10}$ per cent. of the total current was shunted through them, and that the accepted rate of transfer of zinc per second per ampère of current (0·0003392 grams) is correct — really accounted for $\frac{0{\cdot}0314}{0{\cdot}034} \times 100 = 92{\cdot}35$ per cent. of the total work of the lamps.

Considering the fact of the test for electrical energy required to maintain the lamps at brilliancy being made subsequent to the general test for economy of lamp service and illuminating power of lamps, and that the test (for electrical energy) embraced a small number of specimen lamps, the agreement of the work of the voltameters with the observed service of the plant is reasonably close.

It seems to the writer, if the rate of 45 cents per thousand standard candles of illumination, as charged by the owners of the electric lighting plant, is *bona fide*, that the constant 17 by which the deposit or transfer of zinc in the voltameters is multiplied is in error, and should be increased in the ratio of $\frac{1}{0{\cdot}6521} = 1{\cdot}5335$, or should be 26·07; adopting which as the proper constant, the illumination accounted for by the voltameters during the test was the equivalent of $21{\cdot}829 \times 26{\cdot}07 \times 1{,}000 = 569{,}082{\cdot}03$ standard candles, corresponding to an average hourly service of 185·28 lights of 16 candle-power.

From the work of the voltameters, and the special test of specimen lamps for brilliancy and current, the fact seems to be established that for average lamps the electrical energy per unit of light is substantially alike for 16 and 32 candle-power lamps, and the electrical energy per unit of light (candle-power) is practically constant for any given lamp operating under different conditions of potential; that is to say, with a 16 nominal candle-power lamp, yielding with one potential an illumination of 16 candles, the electrical energy is increased or diminished in direct proportion, as the potential and power of the light is increased or diminished. This statement, however, must not be confounded with a previous statement, that as the age (use) of the lamp increases, the electrical energy per actual candle-power of the light also increases, and that the total energy for any one lamp does not vary materially between its highest and lowest power of illumination, but must be understood as applying to a given lamp at a given age.

4. Relation of the Work of the Engines to the Work of the Dynamos, and Relation of the Work of the Dynamos to the Electrical Energy Realised in Lamps.

During the five days of the test (October 13th—17th inclusive), while the engines were being indicated for power, the average indicated horse-power for the day service was 20·306, and the average illumination reduced to lights of 16 actual candle-power each was 95·52.

No tests were made for friction of the engines and jack-shafts, but from tests of similar engines and connectors, it is assumed that of the indicated power during the day services the friction losses were as follows:—

Friction of engine without load	...	1·09 horse-power.
" " additional due load		0·96 "
" " jack shaft	... ...	0·61 "
Total friction	... ...	2·66 "

or about 13 per cent. of the indicated power was absorbed by frictional losses, leaving 17·645 horse-power to be transmitted to the dynamos; of this, however, 3·516 per cent. was lost by slip of belts, and the net power actually delivered to the dynamos was approximately 17·02, or, expressed in terms of electrical energy, 12,696·92 watts.

The lamp service during the daylight hours is given above as the equivalent of 95·52 lights of 16 candle-power; and the electrical energy per lamp, $3{\cdot}377 \times 16 = 54{\cdot}032$ watts; and the electrical energy represented by the actual illumination was:—

$$\text{watts} = 95{\cdot}52 \times 54{\cdot}032 = 5{,}161{\cdot}136,$$

or of the net work of the driving engines transmitted to the armature of the dynamos only 40·64 per cent. was realised in the work of the lamps.

No statement could be made of the electrical energy developed by the dynamos during the day service of the plant, from the fact of the ammeters being so con-

* "Practical Electricity," by W. E. Ayrton, F.R.S., pages 11—12.

structed that considerable current was produced before the index would move from the zero point, and this additive quantity being unknown, readings of the ammeters below 100 ampères could not be made with any degree of accuracy, and were accordingly omitted in making the record of trial.

The statement of the independent work of the dynamos is therefore of necessity limited to the night service of the plant, when the average reading of both ammeters was over 160 ampères, and the least reading of either, 110 ampères; the indications of the instruments being accepted as reasonably reliable after the index passed the first graduation (100 ampères), when the unknown strength of current required to start the needle from zero was eliminated.

In the following table are given the average indications of the ammeters, during the night service, from October 13th to 17th, inclusive, corresponding with the intervals when the driving engines were being indicated for power.

STRENGTH OF CURRENT.

Date.	East dynamo ampères.	West dynamo ampères.	Total ampères.
October 13th	163·330	150·000	313·330
„ 14th	175·909	160·000	335·909
„ 15th	166·875	181·000	347·875
„ 16th	150·000	147·500	297·500
„ 17th	159·000	159·000	318·000
Average	—	—	322·523

The average indicated horse-power during the night service was 70·705, of which the losses by friction are estimated as follows for each engine:—

Friction of engine, without load ...	1·0902	horse-power
„ „ additional due load	1·7131	„
„ „ jack-shaft	0·6092	„
Total friction, one engine ...	3·4125	„
Total friction, both engines ...	6·8250	„

in round numbers, 9·65 per cent. of the indicated power, leaving 63·88 horse-power to be transmitted to the dynamos—less the slip of belts—3·516 per cent., or 2·25 horse-power; and net work of engines actually delivered to the dynamos, 61·63 horse-power; or, in terms of electrical energy, 45,975·98 watts.

The work of the dynamos during the night service was carefully observed, with the following results:—

Average difference of potential ...	99	volts
Average strength of current	322·523	ampères

and average electrical energy, $322{\cdot}523 \times 99 = 31{,}929{\cdot}777$ watts, plus losses not measured between the dynamos and testing instruments. (The ammeters and volt indicators were closely connected with the dynamos, with no intermediate circuit connections, and the losses must have been trifling.)

Of the net power of the engines actually transmitted to the dynamos, $\frac{31{,}929{\cdot}777}{45{,}975{\cdot}98} \times 100 = 69{\cdot}45$ per cent. was realised in the work of the dynamos. This difference of energy, or loss of useful work of over 30 per cent., may be separated into two quantities—that due to friction of the dynamo armatures in their bearings and that due to the resistance in the field of the dynamos. Allowing 7 per cent. of the reduction of work for the friction of the armatures, then 23 per cent. is absorbed in overcoming the resistance within the dynamo.

The lamps in service during the intervals, when the work of the engines and the work of the dynamos were simultaneously measured, were equivalent to 429·319 lights of 16 candle-power; and the electrical energy represented by the actual illumination was:—

$$429{\cdot}319 \times 54{\cdot}032 = 23{,}196{\cdot}96 \text{ watts};$$

or of the net work developed by the dynamos:—

$$\text{E} = \frac{23{,}196{\cdot}96}{31{,}929{\cdot}777} \times 100 = 72{\cdot}65 \text{ per cent.}$$

was accounted for in the electrical energy of the lights.

Omitting the mechanical losses due to friction of engines, extra friction due to load and friction of jack-shafts, only a trifle over one-half (50·45 per cent.) of the net power transmitted to the dynamos is actually realised in the work of the lamps; and taking the day and night service together, which, for commercial purposes, is the proper mode of estimating the net efficiency of a plant for artificial illumination; then of the net engine power delivered to the dynamos but 45·5 per cent. is actually realised in the illumination furnished.

This test was made to ascertain, not particular losses, or causes of loss, but the relative cost of electric and gas lighting, and no other data were taken than enough to determine this question, excepting the special test of specimen lamps (before noted) for brilliancy and current.

The writer is not sufficiently familiar with current literature upon the incandescent electric light to know how favourably the efficiency of this plant as a whole compares with other plants which have been tested, but he has been assured by others interested in lighting that this Central Depot plant was of a representative character, and that upon test it would compare favourably with any other isolated Edison plant in similar service. If this is true, then the large losses between the driving engines and the current generators and between the motive power and the illumination produced should be the means of stimulating electrical engineers to a remedy; the effect of which will, of course, be to reduce the cost of producing the light.

Constructors of Edison electric lighting plants are accustomed to estimate eight 16 actual candle-power lights to each indicated horse-power of driving engines, which, if realised in practice, would have a marked effect on the cost and relative economy of incandescent electric lighting; but from this test, the ratio of lamps of 16 nominal candle-power to each indicated horse-power of engine was—

For the day service, including October 16th (Sunday) ...	4·357
For the day service, omitting October 16th ...	4·728
For the night service, including October 16th	5·547
For the entire daily service (24 hours), including October 16th ...	4·952
For the entire daily service (24 hours), omitting October 16th ...	5·136

It will probably be more accurate to state the number of lamps or lights of 16 actual candle-power per indicated horse-power of driving engines. The average indicated horse-power of engine for the day service, for five days, including October 16th, was 20·306, and the average actual illumination for same time, 95·52 lights of 16 candle-power, and lamps per indicated horse-power—

$$\text{L} = \frac{95{\cdot}52}{20{\cdot}306} = 4{\cdot}704.$$

The average indicated horse-power for the night service, including October 16th, was 70·707, and average actual illumination for same time 429·319 lights of 16 candle-power, and lamps per indicated horse-power—

$$\text{L} = \frac{429{\cdot}319}{70{\cdot}707} = 6{\cdot}072,$$

or, for continuous day and night service, 5·388 lamps of 16 candle-power each per indicated horse-power of engine. From which it will be seen that, even under the most favourable conditions of load and service for this plant the number of lamps per horse-power is 25 per cent. below the proportion of lamps to power assigned by constructors.

Incidental to the performance of the boilers which furnished the steam for the engines the following data are given:—

Non-combustible in the coke ...	5·21 per cent.
Steam per pound of coke, from and at 212 degrees Fahr. ...	8·38 pounds.
Steam per pound of coke, from temperature of feed water (65 degrees Fahr.) ...	7·266 „

The efficiency of the steam from 34 tests was 0·97564, equivalent to an entrainment of 3·336 per cent. of the total feed water supplied to the boilers.

(To be continued.)

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 630.)

V.—MAGNETIC FIELDS IN PRACTICE—(*continued*).

THE armature core last described was formed of iron discs, and had, when built up, the conductors wound on the outside only. In fig. 52 is shown another kind of armature core, B, formed of a number of thin charcoal iron washers laid together, and each separated from its neighbour by paper. The core when built up forms a ring (fig. 53), in which the greater dimension of its cross-section lies parallel to the axis. On this core the conductors are wound outside and inside, the individual loops embracing only the cross-section of the ring, as shown in figs. 52 and 53 at *c c*, and in fig. 54 at *a b*. With the method of joining up these loops we are not at present concerned.

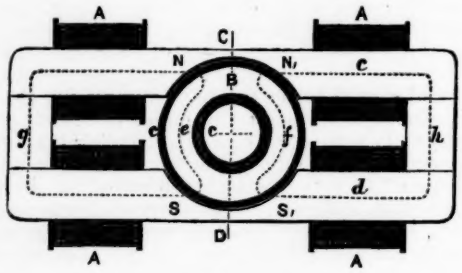

FIG. 52.

Fig. 52 shows the disposition of the field magnet producing the induction, which differs from that shown in fig. 51 by reason of its being divided into two, one half lying on each side of the armature. With perfect accuracy we may say that the field is here produced by two horse-shoe magnets, N_1 *h* S_1 and N *g* S, whose similar poles, N N_1 and S S_1, meet on the line, C D. The right-hand magnet produces the induction through the right hand half of the ring core, *f*, while the left hand magnet produces the induction through the left hand half, *e*. There is a pair of magnetising coils, A A, on each magnet, and the two magnetic circuits into which the arrangement may be

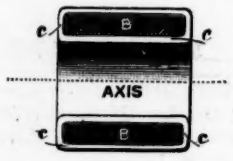

FIG. 53.

resolved are shown by the dotted lines. The right hand pair of coils must supply magnetising force sufficient to produce the induction in the circuit N_1 *h* S_1 *f*, while the left hand pair must produce a similar force for the other circuit. It is of the greatest importance that an equal magnetising force be furnished by each pair of coils. The magnets are formed of wrought iron bars, jointed where shown, and the combination as it stands is termed a double horse-shoe magnet.

In fig. 54 is drawn part of the core and magnet to a larger scale, a single loop of the armature winding being shown at *a b*. This loop is not closed on itself but is one convolution of a continuous helix wound round and round the armature core. When it lies on the line, C D, no lines of force are enclosed by it, while at *f* it encloses the whole of the lines passing through half the core. The reversal in the direction of induction takes place in the latter position, while the former is the position of maximum E.M.F. For the purposes of calculation, some line, *c f d*, which gives the mean length of the magnetic circuit is taken, and the induction in the air gap is assumed to be equal throughout its cross-section. If the actual machine were made as sketched here—that is, with the gap between the core and magnet cavity uniform from *q* to *p*—the lines of force would be crowded into the core at the corners, *p p*, or, since the lines always tend to close by the shortest path, the induction along *n n* would be greater than along *m m*. To ensure greater uniformity in the induction along the polar faces the distance from the core to the magnet increases gradually in some machines from *q* to *p*; but whether this plan is followed or not, there is evidently some uncertainty in the measurement of the length, *r s*. The induction through the armature core is a maximum for some distance on each side

FIG. 54.

of *f*, gradually diminishing from *p* to *q*, and *r s* is chosen so that its length into $f\left(\frac{N}{a}\right)$ gives the ampère-turns, assuming the induction throughout its length to have the value it has at *f*.* As a matter of fact, this length is guessed at from the drawing, and when we remember that the induction here has generally the high value of 18,000 to 20,000, requiring a magnetising force of 150 to 500 ampère-turns per centimetre, it will be seen that a small error in the measurement may mean a considerable error in the number of ampère-turns which we calculate as requisite for producing the induction. In calculating the ampère-turns required for the air gap Drs. Hopkinson show that due to the spreading out of the lines in the space between the magnet and armature; the gap should be assumed as having its cross-section extended all round the polar surface by an amount equal to about ·8 of the distance between the magnet and core. The ampère-turns thus calculated are less than if we assume the cross-section

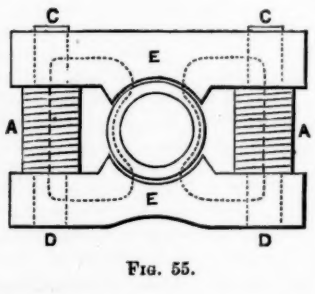

FIG. 55.

of the gap to be confined to the measured pole surface, but agree well with practice.

In fig. 55 is shown another form of double horse-shoe

* The letter *f* in $f\left(\frac{N}{a}\right)$ has, of course, nothing to do with the letter *f* in the diagram.

magnet. Here two massive blocks of cast iron, E, E, are connected by wrought iron bars, C, D, on which the magnetising coils, A, A, are wound. The double magnetic circuit is shown by the dotted lines, there being here one magnetising coil for each horse-shoe, instead of two, as in fig. 52.

Fig. 56 is another form of the double horseshoe magnet, the axis of the armature, B, lying in this case parallel to the axes of the magnetising coils, A, A. The two cast iron side frames, C, D, are connected by two

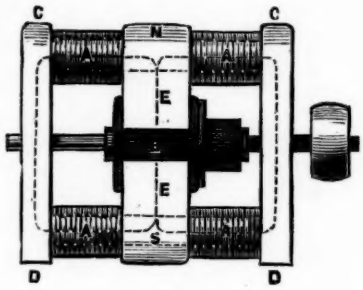

FIG. 56.

massive wrought iron bars on which the magnetising coils are wound. Heavy cast iron blocks, E, E, are fixed one on each wrought iron bar. These convey the lines of force in the required direction from the poles, N, S, to the armature which rotates in the bored cavity between the two blocks. There are two magnetising coils for each horse-shoe, and the magnetic circuits are shown by the dotted lines.

Though an armature having a ring core has been shown in each of the fields, figs. 52, 55 and 56, an armature of the drum type, as illustrated in fig. 51, where the conductors are wound on the outside only, may be employed. We shall find, when describing the various machines of *Class* 3, that for the fields of both drum and ring armatures single or double horse-shoe magnets may be employed.

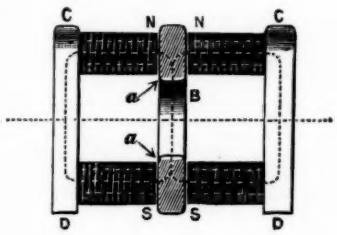

FIG. 57.

Fig. 57 shows a modification of fig. 56, in which the ring core, B, is flattened out to resemble a disc. There are two magnetising coils on each horse-shoe, as formerly, and the magnet poles face the flat sides of the ring. The core is formed, in this case, by winding spirally on a strong inner ring, *a*, *a*, a soft iron ribbon until the necessary depth is obtained. A strip of paper is wound with the ribbon, so that each layer of iron is separated from the neighbouring layer. The magnetic circuits of this arrangement are shown by the dotted lines.

In all these machines there is but one area of influx and one area of efflux for the lines in the armature core. They are, under these circumstances, said to have two poles in their armatures, or are shortly named two-pole machines.

In fig. 58 we come to a somewhat different field, which has been developed, however, from that shown in fig. 57. Here there is a flat ring armature, B, and four horse-shoe magnets, two on each side of the ring. There are two areas of influx and two areas of efflux for the lines of force, the arrangement in consequence constituting a four-pole machine. The poles of the magnets facing each other on opposite sides are of the same sign, the eight magnetising coils, which are wound on the projecting magnet cores, being in the figure omitted. The magnetic circuits are shown by the dotted lines.

From the four-pole machine in fig. 58, to a multipolar machine, is but a step further. In such a machine we have two ring side frames lying parallel to each other, of which, in fig. 59, parts G H, K L are

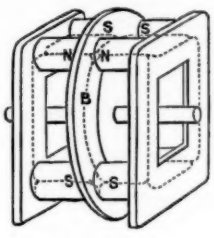

FIG. 58.

shown. On these are projecting cores, which may be cast on the rings, or which may be of wrought iron, attached to them by screws. The projections face each other, and have placed on them magnetising coils, A, A, the direction in which the currents flow in these being such as to produce in the opposite cores similar polarity, as indicated in the figure. In the space

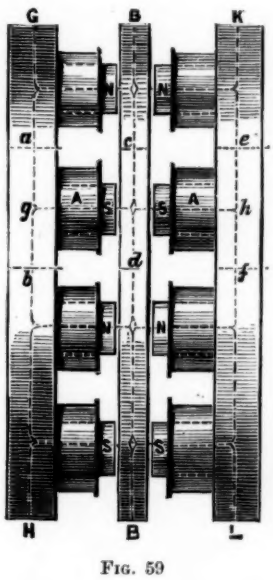

FIG. 59

between these poles lies the flat ring armature, part of which is shown at B, and lines of force are induced in the system, so as to form the adjoining magnetic circuits, indicated by the dotted lines. Considering any pair of coils, A A, it is evident that they must furnish together a magnetising force sufficient to create the induction in the side frames from *a* and *b* to *g*, and from *e* and *f* to *h*; in the left hand magnet core the induction from *g* to S, and in the right hand core the induction from *h* to S, the induction in the air gaps between the poles and the armature, and in the armature the induction from S as far as *c*, on one side of the poles, and from S as far as *d* on the other. Every pair of coils has to furnish a similar magnetising force. When a loop of the armature conductor is midway between the magnets it encloses all the lines of force passing through the core, and as each individual loop occupies this position, *c* or *d*, the direction of the induction in it is reversed. When the loop is directly between the opposite magnet cores, the E.M.F. induced in it is a maximum.

In the four-pole machine, fig. 58, the magnets are of the double horse-shoe type, that is, for each pair of poles in the armature constituted by one area of influx and one area of efflux, there are two horse-shoe magnets. In fig. 60 is shown a four-pole machine, where the magnets are of the single type. There are two distinct horse-shoe magnets, N *a* S, and S *b* N, having wound on each, two magnetising coils, A A. The magnetic circuits are shown by the dotted lines. Considering the top right-hand magnetising coil it evidently must furnish magnetising force sufficient for the induction in the magnet from *a* to N, for the induction in the air-gap between N and *c*, and for that in the armature from *c* as far as *d* in one direction, and from *c* as far as *e* in the other. Each coil must, of course, furnish a similar magnetising force. In this machine the core is not of the flat, but of the elongated ring type, like that formerly described and illustrated in fig. 52.

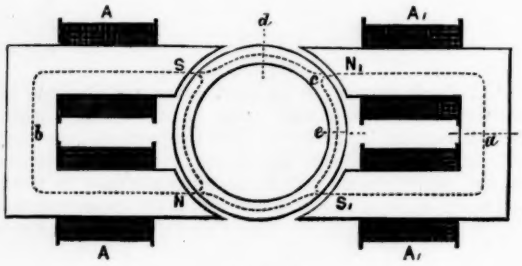

FIG. 60.

The design in fig. 60 is to a certain extent faulty, inasmuch as there is a want of symmetry in the disposition of the magnets, and consequent upon this a tendency to unequal distribution of the lines in the armature core. The lines entering the core from N_1 ought to divide equally, half going to S and half to S_1. As a matter of fact, however, the distribution here is unequal, more lines going by the path *c e* S_1 than by the path *c d* S. In fig. 61 this fault is corrected, the design there shown having the magnets arranged perfectly symmetrically with respect to the armature poles. B is the ring armature core towards which the four magnet limbs are inclined radially. The latter are fixed to an octagonal frame, *a b c d*, and the lines of force take in this frame and in the limbs and ring core the paths shown by the dotted circuits. This design comes in the category of single-magnet arrangements, and for each pair of poles there is one horse-shoe magnet, which has, however, a divided yoke formed by the octagonal frame.

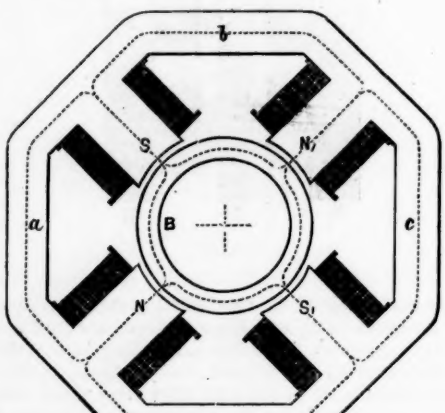

FIG. 61.

From this four-pole machine to the multipolar arrangement shown in fig. 62 is but a step. Here, towards the ring core, B, are inclined radially twelve magnet limbs, which are attached to an outer cast-iron ring frame, C C, and present to the armature core N and S poles alternately. The arrangement may be considered as comprising six horse-shoe magnets with divided yokes, and the induction circuits through the armature magnet limbs and yokes are clearly shown by the dotted lines.

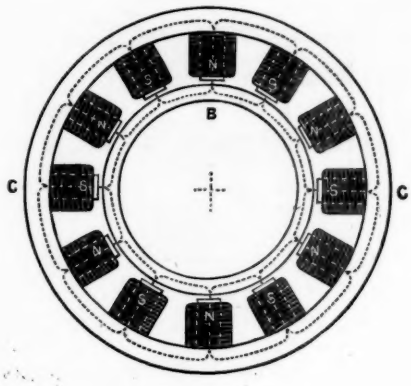

FIG. 62.

These examples may be said to comprise all the various arrangements employed in practice for producing the magnetic field. There is, of course, no limit to modifications which affect the position of the field system relatively to other parts of the machine, but when we come to describe actual machines it will be found that deviations from the fundamental fields here illustrated are traceable to mechanical or economical considerations.

(*To be continued.*)

ELECTRIC LIGHTING ON THE CONTINENT.

IN a previous number we had occasion to remark that many of the clauses laid down by the Paris Municipal authorities for the lighting of the Halles Centrales and neighbouring streets were impracticable. We learn that our opinion has turned out to be correct, since none of the tenders sent in for the lighting of the Halles conformed with the stipulations enacted by the commission. Further delay in modifying the regulations has become a certainty. A small central station is being constructed by the Continental Edison Company, with a capacity of about 1,500 lamps, for lighting the Theatre Français, and the shops surrounding the gardens of the Palais Royal.

In Berlin there appears to be a boom in the electric lighting industry. The central station in the Markgrafanstrasse is to be supplied with four additional dynamos, each of 100 kilowatts. The central lighting stations are to be increased in number, so that there will be ultimately available some 18,000 H.P., with a capacity of 200,000 lamps. The glow lamp business has assumed very large proportions.

From Vienna we learn that a central station is proposed, with a capacity of 10,000 glow lamps. Of the H.P. necessary, 100 H.P. will be obtained from water power. The two new ships of the Austrian Navy are to be fitted by Messrs. Ganz & Co., with 300 glow lamps of 8 and 16-candle-power, two search lights of 40,000 candles, and one of 80,000 candles, each. Several proposals are under consideration for lighting portions of the city of Vienna by electricity.

It is stated that the Grand Hotel in Brussels is to be lighted with 15 arc lamps and 300 glow lamps, and the café attached is to have about 90 glow lamps. Electric lighting is rapidly establishing itself in Ghent, where

most of the factories already make use of it. The Minister of Railways has in serious consideration the employment of the electric light instead of gas at all railway stations. It is probable that tenders will be invited for this work very shortly. The lighting of the Northern Railway station (Brussels) is completed, and it has been decided to use the electric light in the new station at Antwerp.

AN EPISODE IN THE HISTORY OF THE GRAND PRIZE OF TURIN*

THE majority of the journals that have mentioned the death of Lucien Gaulard, justly attribute his death to the worry and vexation of his contests; first with the incredulous, and afterwards with the rivals who envied him his success. The readers of *La Lumière Electrique* are already acquainted with the main facts of the case, and will certainly read with interest the account of the first great experiment in public which gained for Gaulard the prize of Turin and the cross of the crown of Italy, of which he was so proud.

This account shows better than a complete biography the sufferings of the poor inventor; it is taken from a long unpublished memoir revised last year by Gaulard himself, and we give it without changing a word :—

"After having come to an understanding with Messrs. Wurgler and de Lassus, I went to the firm of Siemens Bros., in Paris, to order the material I required, and requested them to apply to the *Banque d'Escompte* for the ratification of my orders, and a fortnight after I was very much surprised to hear that this ratification had been refused.

"I came to Paris to learn from the Baron de Soubeyran the meaning of this refusal. He informed me that all the inventors were on the same footing, but that banking houses were obliged to exercise prudence, that the question required consideration, and he had not had time to go into it.

"Feeling, then, that I must not count upon any help at the Exhibition of Turin, I was obliged to remove the material that I had in readiness for the Metropolitan Railway, notwithstanding the opposition of my company, in order to be ready for the trial to which I had challenged all electricians.

"The competition for the best system for transporting electrical energy to a great distance had been established at the desire of Her Majesty the Queen of Italy, who had been struck by the reports of Marcel Deprez's experiments at Munich in 1882.

"I was surprised to learn on arriving at Turin, that the Scientific Committee had asked the Ministry to modify, and at the same time, extend the programme under the pretext that there would be no competitors for the prize if it were carried out as at first arranged.

"The apparatus having been conveyed to the building for the opening of the Exhibition by the King and Queen of Italy, I had the honour to be presented to their Majesties, who were kind enough to ask me to explain the working of my system, and the difference between my method of transporting electrical energy to a distance and the experiments made previously by Marcel Deprez.

"After half an hour's conversation the King retired, shaking hands with me, and I heard a few days after that a decree had been issued to the effect that the necessary expenses for the experiments of the competition were to be defrayed half by the State and half by the directors of the Exhibition.

"I then undertook, at the Exhibition itself, aided by the kind co-operation of M. Uzel, to measure the rendering of the apparatus by means of Messrs. Joubert and Potier's method, and I showed, to the astonishment of all the electrical engineers representing the administrative and industrial exhibits, that the effective rendering amounted to 90 per cent. When once this result was known I found difficulties multiplying around me.

"Owing to the quarantine imposed by the Italian Government the visitors were few in number, and the Exhibition not being a brilliant financial success, the Administration of the Exhibition did not seem disposed, notwithstanding the decree already mentioned, to pay the expenses of the demonstration that I intended to undertake, by means of a circuit of 80 kilometres, so as to equal that proposed between Creil and Paris. However, the engineer Bignani, director of the Torino-Cirié and Lanzo railway, to whom I owe the deepest gratitude for the help he rendered me from first to last, placed himself entirely at my disposal for the facilitation of my experiments. It was then that we resolved upon the establishment of a line connecting the Exhibition with the station at Lanzo, making use of the telegraph posts. It now remained for me to find the copper conductor, which meant a pretty considerable expense. I then applied to M. Mouchel, a French wire manufacturer, who kindly consented to place at my disposal the 80 kilometres of line that I required.

"I had asked for it to be sent to me express. I do not know through what influence, but in spite of the formal order given by the sender, this wire was sent from Paris to Modane in the ordinary way. When the bill was brought to me I saw that the carriage was charged at the express rate. As I had not the sum necessary to pay it, I sent word to M. Mouchel that the copper had been sent in the ordinary way to Modane, in order that he might make the necessary inquiries.

"But with all companies when one has to make inquiries, the answers do not arrive for a considerable time, and owing to these delays the line could not be completely finished until September 28th.

"But the Jury had decided to break up on the 30th, and as the cholera was then raging at Turin it was impossible to obtain a day's delay.

"I heard on Sunday, September 28th, at 3 o'clock, from M. Bignani, that he had arranged a banquet for the following day, the 29th, at the station of Lanzo, to which were invited the authorities of Turin, the General Committee of the Exhibition, and the members of the International Jury of Electricity.

"I had therefore to prepare to light the station of Lanzo by electricity on that day.

"In the evening of the same Sunday I received notice that the Jury would on the following morning, from 9 o'clock till noon, proceed to measure the rendering of the apparatus at work in the Exhibition.

"At 11 o'clock at night I went to the station at Turin to take there the secondary generators which were on the following evening to work at Lanzo.

"One of my engineers set out on the following morning at 6 o'clock with the apparatus, with orders to get them in readiness and to telegraph to me as soon as he had done so, so that I might send him the current, and test at least once the working of the line and apparatus. I was detained myself at the Exhibition by the Jury to assist in the measurements, which went on until noon. The rendering of 90 per cent. having been verified officially, I had reason to be satisfied, but I waited until 5 o'clock, the hour for closing the Exhibition, for my engineer's telegram, which did not come.

"As the special train started at 6 o'clock, I went to the station where I met my engineer who greeted me with the words: 'I have been waiting for the current since 11 o'clock, until, tired of waiting, I came back.'

"He had, in fact, telegraphed to me at 11 o'clock that morning, and I have never been able to find out how it was his message did not reach me.

"I gave him orders to go at once to the Exhibition and to start the machines at exactly half past 7.

"The special train arrived at Lanzo at 7.20. The banquetting hall was lighted by a few candles. I gave a rapid glance round to see that all the apparatus were rightly placed and in working order, and then waited, watch in hand, for half-past 7 to strike.

"7.30 nothing, 7.40 nothing, 7.45 nothing. I began to despair; all sorts of ideas came into my head: some contact must have been produced on the line, a wire

* J. Bourdin in *La Lumière Electrique*.

might have been cut; for I had been led by experience to be prepared for anything of this kind, and knowing that it would be impossible to repeat my experiment the next day, as the jury would have completed their task, and hearing the laughter and joking overhead, I became almost mad.

"At last, at five minutes to 8, I all at once perceived the electro-dynamometer in motion, and the light then shone out amidst the applause of all the guests. It was not until midnight that I received the explanation of the delay in the arrival of the current at Lanzo, which had nearly cost me so dear. Before the closing of the Exhibition at 5 o'clock, special tickets had been distributed to those members of the staff who would have to return for the evening experiments, which tickets were to be presented at the entrances, but no competent persons were placed at these entrances. My engineer, a Frenchman, unacquainted with Italian, whom I had only met at half-past 5 at the Turin station, was refused admission to the Exhibition by the police. He went all through the town in vain trying to find someone who could explain who he was. At last, effecting an entrance into the Exhibition by scaling one of the walls, he was able to perform his duties half an hour late."

The poor inventor was so terribly overcome by his disappointment, that had the suspense lasted many minutes more, we feel that he would have ended his life there, under the wheels of a locomotive.

Our readers know the rest. The news of the immense and recent success of the American Gaulard-Westinghouse Company took too long to cross the Atlantic ever to reach him, and all that Gaulard gained from Paris, his birthplace, was misery, a lunatic asylum, and death at the age of 38.

NOTES.

Bradford and the Electric Light.—At the monthly meeting of the Bradford Town Council, held on Tuesday last, the chairman of the Gas Committee stated that the electric light would not be in operation at Christmas, as had been expected. It appears that the two engines to be used at Bradford were in course of construction at Willans, London, when the fire occurred on the 24th ultimo. It was found that they had been almost completely destroyed. It will be three months before these engines can be replaced, and there is, therefore, no hope of starting the lighting before the end of March next.

Electric Lighting at Okehampton.—In one of his novels Kingsley applied some very unsavoury epithets to the little town of Okehampton. Since "Westward Ho!" was published, however, a decided change has taken place. A spirit of enterprise has sprung up which has done much to beautify the place and to remove from it those objectionable features with which it was wont to be reproached. It will, therefore, be with no surprise that those acquainted with the genius of modern Okehampton will learn that the electric light has penetrated thus far to the borders of Devon. Mr. Henry Geen, builder and contractor, of Okehampton, introduced the light into his own premises two years ago, the electricity being generated by a dynamo driven by a small turbine and the water-power being obtained from the East Okement, which flows through the town. At present 30 incandescent lamps are used to light Mr. Geen's workshop and house, and arrangements have been made for supplying the light to a number of business establishments, including several of the principal hotels. The wires are to be carried underground in insulated cables laid in glazed socket-pipes, and the charge for supplying electricity will be 15s. per lamp per annum for lighting business establishments until 8 p.m. and 25s. for lighting private apartments. The present price of gas in Okehampton is 5s. per 1,000, and it is computed that this is one-third more than the figure to be charged for electricity.

Electric Lighting of a Dispensary.—The managers of the dispensary in Marshall Street, Edinburgh, have just introduced the electric light into their premises. The lecture rooms and the laboratory have been lighted with it, and it is found to work remarkably well. In the laboratory especially considerable advantage is anticipated from its use. It is easily controlled, the light is admirably adapted for laboratory purposes, and it is healthy to work under. For ordinary purposes the incandescent lamp is used, but the dynamo is capable of supplying an arc lamp, which will be found useful for experimenting purposes in the laboratory. The dynamo is driven by a gas engine, and the managers anticipate that the change will, in addition to other advantages, be an economical one.

Electric Lighting in the Temple.—A petition to the Treasurer and Benchers of the Inner Temple is being extensively signed by the members of that inn against the extensive works at present in progress in the Inner Temple Gardens in connection with the installation of the electric light in the Inner Temple. The petitioners point out, among other things, that the erection of the engines, dynamos, and works in the Inner Temple Gardens will not only seriously depreciate the value of the chambers in the vicinity, but will constitute a permanent eyesore and disfigurement to the gardens. The petitioners therefore pray that, if the extension of the electric light in the Inner Temple cannot be carried out except at such a sacrifice, the scheme be forthwith abandoned. There is surely no need to abandon the idea altogether of lighting the Temple by means of the electric light. Engines and dynamos in the garden probably would be very objectionable, but there should be no difficulty in obtaining current from a central station.

Electric Lighting in Parliament.—Mr. Howorth asked the First Commissioner of Works whether, during the ensuing recess, he could see his way to make such an extension of the electric lighting arrangements in the House as would check further injury to the stonework in the corridors and staircase leading from the Star Court to the Commons' lobby; and whether it would be possible to carry the electric light into the different rooms connected with the Reporters' Gallery. Mr. Plunket: I quite agree in the desirability of the objects sought by my hon. friend, and I have under consideration a scheme for extending the electric lighting of this building, which would include and go somewhat further than the suggestion of my hon. friend; but the cost of the installation would be considerable, and I must obtain the opinion of the Treasury upon its financial aspect. I fear it would not in any case be possible to complete the arrangements earlier than Easter. Sir J. Swinburne inquired whether the right hon. gentleman was aware that the electric light had been so dim in the library that members had had to use candles as auxiliaries. Mr. Plunket thought it must be very seldom that candles were used. He had never seen them in the library.

Pall Mall Company's Central Station.—Mr. E. C. Keevil, who, at the last ordinary meeting of the St. James's Vestry, complained of the huge smoke shaft to be erected within 200 yards of Marlborough House, the Carlton Club, and St. James's Square, at the central station of the Pall Mall Electric Light Company in Mason's Yard, has issued a circular to the ratepayers and inhabitants of the Pall Mall Ward in the hope of convening a public meeting for the purpose of obtaining an injunction to remedy the contemplated serious nuisance. He points out that the vibration of the machinery, which will be of a very massive character, together with the smoke of the works, going on day and night, will be so great a nuisance that many houses in the immediate neighbourhood will become vacant, as was the case in Paddington. Such an installation in their very midst was calculated to seriously injure the interests of clubs, hotels, and private residents.

The City and the Electric Light.—At the meeting on Tuesday of the City Commission of Sewers, Mr. Treloar asked when they were to receive the report of the Streets Committee as to electric lighting, and why it had been delayed. Mr. Bridgman replied that the committee had done all they possibly could in the matter. They had decided upon the principle upon which the conditions for tendering would be based, and the matter was now with the officers. The engineer had communicated to him through Mr. Preece, the electrician consulted, his views, which had been sent to the solicitor, who had considered the documents and returned them. The engineer was putting the matter into proper shape, and as soon as this was done the committee would be glad to discuss it. The committee had determined that the matter should be settled before they went out of office, so that before a new Commission was appointed he (Mr. Bridgman) believed they would be able to report that they had arrived at satisfactory conditions. Mr. Morton, as a member of the committee, would like to say the committee had been playing with the question a whole year, and wasting time. Mr. Rose-Innes asked whether it would be open to private persons or companies to tender. Mr. Bridgman replied that it would be publicly advertised, and the conditions would be sent to those who applied to tender.

Chapel Lighting by Electricity.—On Sunday evening, the 1st inst., Regent's Park Chapel was lighted by electricity. The body of the chapel is lighted by eight pendants, in the form of an octagon, from the ceiling, and the gallery by twelve incandescent lamps, which are attached to gas standards. There are also several lights under the gallery.

Electric Lighting at Suakin.—A *Standard* telegram from Suakin states that Engineer White, of H.M.S. *Racer*, and Engineer Mason, have just completed an installation of the electric light at various points of Quarantine Island, including the hospitals there. A trial has been made, and the system has been found to work satisfactorily. The hospitals on the island are lighted by electricity.

Post Office Telephones.—Of the 23,000 telephone subscribers in the country, under six per cent. belong to the Post Office exchanges, the remaining 94·95 per cent. being connected with the exchanges of the companies. One half of the 1,320 Post Office subscribers are in the Tyneside district.

Continental Telegrams.—Sir. G. Campbell asked the Postmaster-General last week if he could give any further information as to the new arrangements for telegraphy to the Continent, and the rates to be charged; whether it was true that it was proposed still to charge twopence per word to France and Belgium, of which at least one penny was for cable transit across the Channel; and whether, at the modern cost of manufacture, a paying cable could be laid across the Channel at a less rate than one penny per word. Mr. Raikes said that under the new arrangements the charge, which was now twopence-halfpenny, would be reduced to twopence. No particular portion of the charge had been assigned to cable transit. He was not able to give any information as to the latter part of the hon. gentleman's question.

Extension of Telegraphic Service.—It is stated that the Postal Telegraph authorities are making arrangements for an important extension of the telegraphic communication between Glasgow and the North-West of England. From Glasgow the new line of wires will be carried along the Carlisle Road until Beattock, in Dumfriesshire, is reached. The route then will be through Central Annandale to Lochmaben, thence by Dalton to Annan, and across the Solway Firth to England. Several places at present without telegraphic communication will be accommodated.

The Channel Cables.—Sir G. Campbell asked the Chancellor of the Exchequer on Monday whether he could give the House an assurance that any cable or plant taken over from the company which had had for a long term a monopoly of telegraphic communication accross the Channel, would not be taken at a price exceeding the actual present material value, and that the community using the Government cable in future would not be subjected to charges due to an excessive price paid as any sort of indirect compensation to the company for the loss of a monopoly so long enjoyed. The Chancellor of the Exchequer replied that it would be impossible for him to make any definite and full statement to the House on the subject until the termination of the negotiations now in progress. He could, however, assure him that the interests of the public would be safeguarded in every possible manner, and he hoped he should soon be in a position to make a satisfactory statement to the House upon the question.

Swinburne's New Filaments.—Mr. Jas. Swinburne writes:—From your footnote to the lucubration on lamps from cabbage, your readers might gather that I was the author of the hoax. This is not at all the case. Moulsham, the residence of the suppositious Mr. Vandeleur, is infested with Messrs. Crompton's pupils, and doubtless one of them was suffering mentally from reading a little (no one could read much) of the Attorney-General's speech in the Edison Appeal, and saw as clearly as the learned counsel himself that pickled cabbage was "particularly described and ascertained" by the words "any fibrous vegetable material."

Electrical Supplies.—The production of a catalogue of electrical supplies, which can claim originality as well as diversity, involves an amount of thought and care seldom recognised. New inventions and improvements succeed each other with such rapidity that it is difficult to keep pace with the variety of demands, especially when fashion or artistic display, as well as utility, enter into consideration. A few years ago electric light contractors had to work out every small detail for an installation, and worry their brains over such things as lampholders, shades, switches, cut-outs, and the like, whereas now they can walk into establishments containing samples of an endless variety of such things from which they can choose what best suits their requirements. Good catalogues, if largely illustrated, may even save them the trouble of going round to the different warehouses; at any rate the one before us, just issued by the General Electric Company, contains such excellent pictures that anyone can almost select what he wants without even seeing the articles of his choice. In this book we find close upon 300 woodcuts of all sorts of fittings and instruments, some well-known to the trade, others specialities of this company, such as improved China bases for switches and cut-outs, which have of late been developed, and which in style and finish are far superior to most we have seen on the other side of the Atlantic, or on the continent. The cutting of fine threads upon China bases seems to be a new creation brought about by this firm, and it does away with brass screws and metal caps, which have always given more or less trouble in electric light switches. The catalogue contains an endless variety of artistic designs of shades and other glassware, and we notice many novel and striking ideas developed, very different from the forms we are accustomed to see on gas fittings, and particularly characteristic of the new illuminant. It also contains numerous tables, and prices of almost every conceivable necessary for a complete installation; it may, therefore, answer as a book of reference, as well as an advertisement, to all who care to apply for it.

Lecture. — Before the Edinburgh Architectural Association, last week, Mr. Archibald C. Elliott, D.Sc., assistant to the Professor of Engineering in the Edinburgh University, read a paper on "Recent Departures in Electrical Engineering."

Maxim-Weston Electric Company.—Mr. John Marks, chairman of the Maxim-Weston Electric Company, writes to the *Financial News*: Mr. Hugh Watt (through his solicitor) lost no time after the meeting of the Maxim-Weston Company on the 3rd inst., in informing your readers that he had commenced an action against me for slander in having told the shareholders what I did. He has not informed you that he has also served me with notice that he intends moving the Court on Friday next for an order to place me in prison for contempt of Court, for having stated that the last balance-sheet was absolutely false, as shown by the report of Messrs. Boyce and Ramsay, the chartered accountants employed by the board. I think it right the shareholders should know the methods of intimidation resorted to by the late chairman and managing director (Mr. Hugh Watt), and I shall therefore feel obliged if you will kindly find place for this.

Royal Institution.—Amongst the probable arrangements for the Friday evening meetings before Easter we notice the following fixtures: February 8th, 1889, Sir William Thomson, D.C.L., LL.D., F.R.S., M.R.I., "Electrostatic Measurement;" February 15th, Prof. A. W. Rücker, M.A., F.R.S., M.R.I., "Electrical Stress;" March 8th, Prof. Oliver Lodge, LL.D., F.R.S., "The Discharge of a Leyden Jar."

A New Electrical Journal.—A new paper entitled *The Telephone* will be published on the 1st January, 1889. The issue will be fortnightly—on the 1st and 15th of each month. In addition to electrical information of a general character, special prominence will be given to the science of telephony, as well as to foreign intelligence. A circulation of 5,000 copies will be guaranteed of the first number. We wish the new venture every success.

The Electric Light in Land Warfare.—On Saturday night some interesting experiments were made on Hampstead Heath, for the purpose of testing the capacity of small electric hand lamps in searching for the wounded men left after a battle, and thus more rapidly than hitherto bringing the sufferers within reach of surgical aid. The experiments were made by the officers and men of the London Division of the Volunteer Medical Staff Corps, an organisation which already consists of four efficient companies, largely composed of medical students, and for which a fifth company is now in process of formation. The corps, under Surgeon-Commander Norton, accompanied by ambulance waggons and provided with stretchers, halted upon one of the Heath roads, at a time when the thick mist still hung heavily upon the lower grounds; and having established a field hospital in a rather dreary-looking spot, poorly sheltered by bare trees, sent out its searching stretcher parties to pick up the bandsmen who had been distributed over the open ground at some distance off, to simulate the wounded left from a fight during the daylight. By the aid of the lamps thus brought into such a use for the first time, the men sought were found with comparative rapidity, the lights being sufficient also to enable the trained ambulance men to apply preliminary bandaging upon the spot before loading the stretchers, which by other lights at the waggons were guided back to the road. There the men were carefully placed in the vehicles and conveyed to the field hospital, where the examining surgeons found very little to correct in the treatment adopted under such disadvantageous circumstances. The results achieved indicate sufficiently well that the electric light thus used would be of immense value, and tend greatly to reduce the suffering of men left upon the field at the close of a fight.

Curious!—*Invention* last week contained a scathing article on "Electro-Medical Appliances and Shams," and yet amongst its advertisements was that of one of the most notorious electro-medical pretenders, against whom there was internal evidence the article alluded to was mainly directed.

The Promotion of Companies.—We should imagine that by this time Dr. Frankland regretted having anything to do with company promotion. He now finds himself, to the regret of everyone who knows him, in rather an awkward position. The names appearing on the prospectus of the Mining and General Electric Lamp Company as those of directors were six in number. Of these two were to join the board after allotment. Three, Lord Crawford, the Hon. Reginald Brougham, and Mr. J. Y. Stephen, resigned before allotment, leaving only Dr. Frankland as a director. Yet the allotment took place! One director cannot act alone, and the allotment, under the circumstances, can scarcely have been legal. We are quite certain that Dr. Frankland acted in perfect good faith in whatever he did, and we can only commiserate with him in the dilemma into which he has unfortunately, and, we believe, unconsciously, fallen. At the same time we think he was ill-advised to identify himself with such a scheme as that promulgated in the prospectus of the Mining and General Electric Lamp Company, our opinions respecting which have already been given.

Personal.—Mr. Mountain desires that it should be understood that he is leaving the Gülcher Company on the most friendly terms, and that Mr. G. C. Fricker, who was formerly chief electrician to the company, will take the position vacated. Mr. Mountain has every reason to believe that under the new management the Gülcher Company should succeed, especially seeing that the business the company is now doing is of a most satisfactory and profitable character, and he therefore leaves the company, believing that with the improved prospects of trade it will be successful in the future.

Trade Marks.—Mr. Harness threatens to make a fight for the monopoly of the word "electropathic." Our readers will remember that a company was recently registered under the title of "The Electropathic and Turkish Baths Company," and the Medical Battery Company, through its managing director, announces that "we are the sole proprietors of the word electropathic," and that it has instructed its solicitor to issue a writ to restrain the other company from using it. We contend that it is impossible for any individual or corporation to appropriate a word to its own use and restrain others from using it in any way they may think fit—that is to say, a word which has been in general use and is well known, as is the case with electropathic. Mr. Harness did not invent the word "electropathic;" it was used in connection with medical electricity long before he embarked upon his perilous career towards "eminence." The Courts are not likely to support him; he knows this, and probably will not proceed with his writ.

Belgian Commission for the Application of Electricity in Coal Mines.—We learn that a Royal Commission of mining inspectors has lately been instituted in Belgium for studying the conditions of security to be provided in the applications of electricity underground in the workings of the collieries (particularly in the fire-damp ones) for firing, for fixed and portable lighting, and for transmitting motive-power. The president of this commission is Mr. Roberti, principal inspector, Brussels, and the members are the following inspectors:—Mr. A. Macquet, from Mons; Mr. J. Libert, from Liege; and Mr. E. Masson, from Charleroi, secretary; all electrical engineers. The first meeting took place on Monday week.

Society of Telegraph-Engineers.—Mr. Mordey suggested, last Thursday night, that it was not quite desirable that Mr. Preece's statement of his views should be put forward alone for members to form an opinion. Mr. Preece very ably expressed one view, but if notice had been given it was probable that a strong expression of an opposite view might have been heard. He thought the circular to be issued should state bare facts, and leave the members to form their own opinion on the subject.

Legal.—United Telephone Company *v.* Ericsson-Bell Telephone Company.—On the 11th inst. Lord Trayner closed the record in an action at the instance of the United Telephone Company, London, against the Ericsson-Bell Telephone Company and Charles Bell, the only known partner of that firm, which carries on business at 29, Waterloo Street, Glasgow. The pursuers ask that defender should be interdicted from infringing letters patent assigned them by the Edison Telephone Company in 1880, and by Alexander Graham Bell, Boston, in 1878. There are also conclusions for £1,000 damages, and that defenders should deliver up all the instruments which have been constructed in infringement of pursuers' letters patent. The defender had a stall in the recent International Exhibition in Glasgow, and the pursuers aver that he sold instruments there which were an infringement of their patents. The defence is a denial of the infringement, and defender pleads that the damages claimed are excessive.

Solar Source of Power.—Mr. Edward Weston, the well known American electrician, suggests the idea of using a thermopile, placed in the focus of a mirror or lens, and used to charge a storage battery from which the energy is finally drawn. Long since, says the New York *Electrical Review*, it was suggested to use Ericsson's solar engine in connection with the dynamo, but as the solar engine is more expensive than the steam engine, and only intended for countries like Upper Egypt, where fuel is scarce and costly, the project was abandoned. But there is, we think, the germ of a valuable idea in Mr. Weston's suggestion.

Charity and the Phonograph.—The *Financial Times* says:—"We once before remarked that good old Colonel Gouraud was always excellent at advertising. His hand has evidently lost none of its cunning. 'Phonograph at homes for Christmas Charities,' is right down good; but this is better: 'Colonel Gouraud dedicates Mr. Edison's phonograph to the season's charities, with selections from his interesting phonogram cabinet, and has arranged with an experienced lecturer to give explanations and practical demonstrations, illustrated by lantern slides, &c.' We, moreover, learn that after the expenses of the lecture have been defrayed, the balance of the sum agreed upon will be *jointly*—jointly by whom?—handed over to the charity previously approved. All communications are to be addressed to Prof. E. Douglas Archibald, M.A., Bridge House, Queen Victoria Street, E.C. This surely 'takes the cake' for a happy blend of charity, business 'push,' and company promotion. The Colonel has dabbled so much in science that he now seems able to combine absolutely discordant elements."

Electricity and Artesian Wells.—The discharge of water from artesian wells has for many years been employed as a motive power in France. A project is now before a Commission of the Municipal Council of Paris, having for its aim the utilisation of the power obtainable from the new artesian well in the Place Hébert, at La Chapelle. The La Chapelle well was finished in March last, having been begun 24 years ago. It reaches a depth of 720 mètres, and the water, left to itself, rises to a height of 35 mètres above the mouth. It furnishes 6,000 cubic mètres of water in 24 hours. The proposal is to utilise the power furnished by the well in generating and distributing electricity for lighting and motive purposes. One object mentioned is the lighting of the park of the Buttes Chaumont, which is situated near the well. Before now electricity has been generated in this manner. At Ponce de Leon, in Florida, there is an hotel having a powerful artesian well, which drives a turbine wheel and dynamo, thus generating the current necessary to light the building and its grounds. At Yankton, in Dakota, there is a flowing well which drives the dynamos of an electric light company. The well is 600 feet deep, and the water on issuing from it is conducted to a reservoir placed 30 feet above the turbine which actuates the dynamos.

A Novel Christmas Number.—Our contemporary, *Invention*, will publish next Saturday in its Christmas number a novel cartoon, entitled "The Fair Friends of Ireland." It contains excellent portraits from photographs kindly supplied of over 50 ladies who kindly lent their aid at the Irish Exhibition, either as members of the Ladies' Executive Committee of the Women's Art and Industrial Section or as lady patronesses at the Fashionable Fancy Fair at the Old Irish Market Place, on July 17th, 18th, 19th, and 20th. The feature of the design is a wreath of shamrock, on the leaves of which the portraits are arranged. Representations of the Old Irish Market Place and of Irish women's work are also included.

The United Electrical Engineering Company.—Messrs. Manville and Madgen, the managing directors of this company, inform us that they are moving their offices and showrooms to more commodious premises on the ground floor at No. 3, Princes Mansions, Victoria Street, Westminster, S.W., the change to take effect as from the first of the year.

Screwing Machine.—The Britannia Company has recently introduced a new patent screwing machine (McIlquham's patent) said to be constructed on improved and very simple principles greatly advantageous to users in point of economy, both in working and maintaining in order. The makers will send full particulars to enquirers.

NEW COMPANY REGISTERED.

British Electric Tramways and General Syndicate, Limited.—Capital: £10,000 in £5 shares. Objects: to construct and equip railways, tramways, and other ways in England and Wales, and to work the same by electricity, animal, steam, or other power; also to carry on the business of an electric light company. Signatories (with 1 share each): J. W. Haynes, C.E., Forest Gate; H. D. Poole, 33, Chancery Lane; J. C. St. Aubyn Angove, 27, Chancery Lane; E. de Pass, 68, Fleet Street; J. A Bunhill, 42, Mildmay Park, N; J. Walsh, 81, Gracechurch Street; F. H. Bromwich, 13, Upper Woburn Place. The first directors are to be Mr. J. W. Haynes, and two others to be elected by the subscribers. Remuneration £10 per cent. on the net profits. Mr. J. W. Haynes is appointed managing director for seven years and Mr. J. E. Haynes, of Carisbrook, Isle of Wight, is appointed engineer to the company. Registered 15th inst. by J. C. St. Aubyn Angove, 27, Chancery Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Blackpool Electric Tramway Company, Limited.—The annual return of this company, made up to the 12th inst., was filed on the 13th inst. The nominal capital is £30,000 in £10 shares, the whole of which are allotted. Upon 2,850 shares the sum of £6 10s. per share has been called, and the full amount has been called upon the remaining 150 shares. The calls paid amount to £20,021, and unpaid to £4.

Eastbourne Electric Light Company, Limited.—The annual return of this company, made up to the 8th ult., was filed on the 14th inst. The nominal capital is £50,000, in £10 shares; the shares taken up being 1,012 ordinary and 40 preference, upon which the full amount has been called. The calls paid on the ordinary shares amount to £10,120, and the preference shares are considered fully paid.

Electrical Accumulator Association, Limited.—The statutory return of this company, made up to the 14th inst., was filed on the same day. The nominal capital is £10,000, in £10 shares. 450 shares have been taken

up, and the full amount has been called and paid thereon. Registered office, 17, Gracechurch Street.

Humboldt Electric Power and Mining Company, Limited.—An agreement of 1st ult., filed 17th inst., the Consolidated Esmeralda Company and W. F. Gardener for this company, provides for the purchase by this company of estate and properties in Nevada, including hoisting engine, plant, locomotive, reel cages, &c., for £15,000 in cash, and £15,000 in fully paid shares. This agreement was confirmed on the 11th inst.

An agreement of the 1st November, filed on the 17th inst., between A. E. Ann and W. F. Gardner, relates to the purchase of mineral property in Nevada for £7,500 cash, and £12,500 in fully paid shares. This agreement is confirmed by a supplementary agreement, dated 11th inst.

Mining and General Electric Lamp Company, Limited.—The registered office of this company has been removed from 43, Coleman Street, to 11, Abchurch Lane.

Electropathic and Turkish Baths Company, Limited.—The registered office of this company is situate at 8, Old Jewry, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

Woodhouse and Rawson, Limited.

AN extraordinary general meeting of this company was held at the Cannon Street Hotel, E.C., on Friday, December 14th, Sir John Stokes, chairman of the company, presiding.

Mr. J. Shurmer, the secretary, having read the notice convening the meeting,

The Chairman said: Gentlemen, this meeting is called, though not strictly necessary, in order that we may have confirmed by you the auditors that we have temporarily appointed, and also in order that we may let you know the arrangements that are in progress with reference to the extension of the business and have your confirmation of the same. You will be glad to hear that since we had the pleasure of meeting you some six months ago we have gone on improving the organisation of the company, which now we have got into good working order. In our installation department we have, during the past year, done work for Messrs. Peak, Frean and Co., the London Stock Exchange, Lord Brassey, Messrs. Guinness and Son, Messrs. Crosse and Blackwell, Drapers' Hall, Exeter Asylum, Messrs. W. H. Smith and Son, the Institute of Medical Electricity, and many other important firms and companies, and we have at the present time in hand orders for lighting of the Palace of Mysore, Sir Frederick Carden, Messrs. J. W. Benson and Co., extensions at the Drapers' Hall, together with other installations of varying degrees of importance. We are also in negotiation at the present time for the sub-contract for lighting one of the most important districts of London, which sub-contract we expect will come to considerably over £100,000. In our subsidiary company working in Yorkshire, besides having put up installations throughout the district, there are a number of establishments in Bradford at present being fitted up by them, there being over 20 places, such as the six principal banks, &c. Besides this large increase in our business there has been a striking advance in electrical business generally, and, as far as we can judge, there is likely to be a still greater increase. To give an idea of this growth, it may be mentioned that we have not yet in any way felt the large increase that there will be in electric lighting derived from such companies as the London Electric Supply Corporation, Limited, with its large works at Deptford, the Metropolitan Electric Supply Company, and many of the other central stations that are being now started. It must be recollected that Woodhouse and Rawson, Limited, and its subsidary companies lay themselves out for working for companies of this description, and that we hope to obtain a large amount of work resulting from their increase. To give an instance of the extraordinary increase, we may mention that the turnover in electrical supplies of the Woodhouse and Rawson Electric Supply Company of Great Britain, Limited, one of our subsidiary companies which does a merchant's business in buying and selling electrical goods and goods connected therewith, has increased nearly threefold during the last six months. Foreseeing this increase some little time ago, the Woodhouse and Rawson Electric Manufacturing Company consulted us with regard to the extension of their company, as they quite saw that their company in its existing state would be unable to cope with their business, and it was arranged to enlarge the company. As an instance of this increase I may mention that they recently received an order for over 100,000 switches, the largest order ever given out. They also are in negotiation at the present time for an order for 200,000 incandescent lamps, and even at the double rate of their present turnout these two orders would fill them up with work for many months to come in their respective departments. The manufacturing company also wished to obtain the advantage of an amalgamation with another well-known business in the North of England, which also had a very great increase of business, and was about to enlarge. We were in negotiation, also, ourselves for the purchase of various properties which we considered of value to our business, and on finding that the manufacturing company intended themselves to increase, we suggested their acquiring the properties we were in negotiation for. At this date there had been negotiations for some time between the company and Mr. Rawson for the purchase of the founders' shares, as it was quite evident that, should the business go on as we expected, it was advisable for the company to exercise its option and purchase these founders' shares. Our legal adviser told us, however, that it would be almost impossible to do this without the formation of a new company, as the company could not purchase its own shares. Under these circumstances we considered it advisable to make an amalgamation, and we found that several other companies would be willing to join us. It may take a little time to complete this arrangement; but we wish to have the support of your approval to our doing this, on the basis that the shareholders receive a bonus upon the amount paid up on their shares, and that there will be certain assets left in our hands, from which we hope considerably to increase this bonus. At the present time we are paying dividends at the rate of 12 per cent. per annum, and we hope that by this amalgamation we shall be enabled to increase this dividend, as we shall not then be obliged to set aside the large amount we now have to pay to the founders' shares. As you can quite see, it will not do to give any details of this amalgamation until it is further forward. You may recollect that at the meeting about six months ago I stated that we had just completed an arrangement of great importance to us. I am glad to say that this arrangement is now finally completed and in every way carried through, but I am not yet at liberty to divulge the same, as the interests at stake are too important. There is a company coming out in a short time called Elmore's Patent Copper Depositing Company, Limited, to work a process which we ourselves, as well as the most eminent experts in such matters, consider one of the most valuable inventions discovered for a long time. We have been engaged in this for the past few months, and feel confident of making a large profit from the same. With regard to the matter of auditors, the late Mr. William Spain had, before this company was formed, acted for Messrs. Woodhouse and Rawson, and his firm, Messrs. Spain Brothers, were appointed as auditors to our company. We regret to have to say that since our last meeting Mr. William Spain has died, and we have appointed as auditors to the company Messrs. Chandler, Pixley and Co., and Mr. Champness, who, until shortly after Mr. Spain's death, was a partner in the firm of Messrs. Spain Brothers, and who attended to Mr. William Spain's work. Messrs. Chandler, Pixley and Co. are well-known auditors, and are already auditors to one of our subsidiary companies. It is necessary to have this appointment confirmed. The first point I will put to the meeting is that Messrs. Chandler, Pixley and Co. and Mr. Champness be appointed auditors of the company.

Mr. Hayes seconded the motion, which was at once carried.

The Chairman said he would now put it to the meeting that they give their moral support to the directors in doing that which they had the power to do; but which was a matter of such importance that they preferred to have the confirmation and approval of the general body of shareholders. He referred to their merging Woodhouse and Rawson, Limited, in a larger company, which would give them a wider field of action and hold out every prospect of success. He would ask Mr. Rawson to explain the position further.

Mr. Hayes: Will Mr. Rawson tell us that the interests of the shareholders will be safeguarded?

Mr. F. L. Rawson: I may state that the interests of the shareholders have been carefully looked after by the directors, and naturally so, the directors being amongst the largest shareholders, holding between them a very large proportion of the capital. We have done everything we could to make this new company such as will both command the amount of work that is necessary for such a company, and also bring in, as the chairman stated, a larger dividend even than that paid before, that being done by the obliteration of the founders' shares.

Mr. W. Reed: Will it necessitate a voluntary winding up?

Mr. Rawson: I should think it would do so, but everyone will know that it is only a formal matter, on account of the business being carried over. Questioned as to the cause of the difficulty in selling shares readily on the market, Mr. Rawson said the company paid dividends only on £70,000, and they could not, therefore, get a quotation, and people who wished to buy or sell had to wait the opportunity offered by someone else wanting to buy or sell shares at the same time. One great gain which would be obtained by the present scheme was that they would get a quotation.

The Chairman, replying to Mr. Reed, said that by the proposed arrangement the bonus could be taken in cash or shares in the new company, at the option of shareholders, for the amount of the old shares paid-up.

Mr. Rawson said, in reference to the partly paid-up shares, they had at present arranged that the shareholders of Woodhouse and Rawson, Limited, should have a bonus of so much per cent. in the new company, according to the amount paid up on their shares at the date of the handing over, and in addition, that, Woodhouse and Rawson, Limited, should keep certain assets, and realise those assets and distribute them amongst their shareholders.

There was an important matter to mention, and that was, that one of the largest holders of partly paid-up shares had seen him once or twice on the subject, who complained that it would be unfair that the shareholders who had, as he expressed it, borne the heat and burden of the day when the company was first formed, and it was not known whether it was going to be a success or not, should not participate in the same way as the holders of fully-paid vendors' shares. Of course, it made the greatest difference to Mr. Woodhouse's executors and to himself (Mr. Rawson), but as regarded himself he had agreed with the board that if any partly-paid shareholders cared to pay up on their shares before the arrangement was concluded they could do so, and in that case participate in the bonus. Therefore he believed he was right in saying the board would be prepared to receive the amounts of unpaid shares, in which case the holders would receive the bonus on their shares in full and from the assets which were going to be realised; that was, in proportion to the amount they had paid up at the date of the amalgamation.

The Chairman stated that this was the case.

Mr. Reed: Will the dividend due now be sunk in the bonus of the new company?

Mr. Rawson: Not the dividend to be paid on the shares up to June 30th. That will be paid when we get the auditors' report passed by the general meeting.

The motion was agreed to and the proceedings terminated.

"Pilsen," "Joel" and General Electric Light Company, Limited.

AN extraordinary general meeting of this company was held at the Cannon Street Hotel on Friday, December 14th, under the presidency of Sir Rawson W. Rawson, K.C.M.G., C.B., for the purpose, if thought fit, of passing resolutions for the voluntary winding up of the company.

The notice convening the meeting having been read,

The Chairman said there was no need to say much. The directors, acting upon a recommendation passed at the last meeting, had taken the necessary steps depending upon them, and they now called upon the shareholders to take the necessary steps on their part to carry out what appeared to be the wishes of a large majority of the shareholders at the last meeting. They, the directors, had merely given mechanical expression to what was supposed to be the wish of the last meeting, and the question was now formally before the shareholders. He moved the first resolution on the notice, "That the company be wound up voluntarily under the provisions of the Companies' Acts, 1862 to 1886."

Mr. Whately seconded the resolution.

Mr. Fellows said before this important step was taken he wished to offer a few observations for the consideration of the shareholders. That resolution, if adopted, meant that they handed over the whole of their property out of their own control into the hands of two persons before they had any scheme and before they knew what those persons would do. The liquidators could sell the property for what they liked, for an old song if they liked. He did not think the company had yet reached the stage at which that should be possible; he did not think either the directors or the shareholders should relinquish their control until they knew how the liquidators were going to dispose of the business. When they had prepared a scheme would be the proper time to call the shareholders together and appoint liquidators for the purpose of winding up, He would suggest that the matter should be deferred for three months, or, if they thought that was too long a period, for two months, so that they might have an opportunity of turning round and seeing their position.

Major Scriven: You have had since last March.

Mr. Fellows: As you have mentioned that—I did not wish to say it, but I must—I think it is largely owing to the directors themselves that opposition has been raised.

Major Scriven: You appointed your own committee, and you have their report.

Mr. Fellows, continuing, said he wished to avoid everything that would irritate and to propose only what was likely to be of benefit to the shareholders generally. He had not come with a hostile feeling towards the directors; he differed from them, but in a friendly way. The great objection to them was that they wrote down the patent and goodwill account by £25,000, which they should have been the last to do if they wished to sell the property. They said they could not pay a dividend until they did that. But he had seen a solicitor and an accountant upon the matter, and they both said they had never heard of such a thing, and could not understand it at all; if they really made a *bonâ fide* profit they could divide it, whether £1,000 or £50,000; patent account or goodwill had nothing whatever to do with the matter. He believed their patents were exceedingly valuable. Mr. Fyfe could tell them that he had had very important offers made to him from abroad for the Pilsen light, which was by far the best arc light that existed, The patents for that alone should be worth a very considerable sum, seeing that they had the rights for the Indian Empire, Canada, Cape of Good Hope, Scotland, Ireland and all the counties of England, if they chose to develop them. The patents were either worth a large sum of money, or they were simply rubbish and worth nothing at all. Then there was the Schuckert dynamo, which was used largely both in America and on the continent of Europe. He was quite certain that Mr. Gwynne's offer would have been accepted if he would have agreed to admit any shareholder who chose to go in upon the same terms as he (Mr. Gwynne) himself bought. Why should not that be done now?

Major Scriven: But Mr. Gwynne will not repeat his offer.

Mr. Fellows believed others would come in, and suggested that a committee should be formed to purchase and make some arrangement of that kind. Ignoring the matter of patents and goodwill they had a valuable property in their installations. Those who had charge of those installations were quite competent to manage them themselves, and there was no need whatever for a central staff, unless they were going to extend their business. He was told that the Bethnal Green installation, after paying all expenses, showed a net profit of between £700 and £800 a-year; the net profit of the installation round about the factory was about £500 a-year, and that of the Whetstone Park installation was about £200.

Major Scriven: But you and everybody have been told that since last March.

Mr. Fellows said he was only going to draw a conclusion from the facts. It was very unpleasant for him to attend there, at great personal inconvenience, but he felt it was a public duty. He had been a director of the company, and felt it a kind of disgrace to himself that they should cry *peccavi*. It threw disgrace upon the whole of them.

Major Scriven: I think so, too.

Mr. Fellows said, therefore, he wished to see if they could not do something to pull the concern around. He repeated that he thought the installations might be made self-managing, and thus avoid the necessity of the central expenses.

Mr. Gwynne said all this had been threshed out dozens of times. If Mr. Fellows thought so highly of the concern why on earth did he not buy it himself and make the wonderful profit of which he spoke. After all, the position was this: they could not maintain those installations at a heavy loss.

Mr. Fellows said there were three installations and Mr. Trentham was quite competent to attend to the whole of them. He did not wish to buy the concern himself because he was not in that line; he was not an engineer. Tehe expnses of the year amounted to £1,258, and that was expended mainly in enabling them to produce about £700 a-year. If he were a director he should be perfectly willing to do as he had done before and take no fees until they had pulled the concern round; he should feel it a point of honour to make a sacrifice. It had been suggested to him that a company might be formed to purchase the three central stations, or that the customers might come forward and take over the thing themselves. But he thought they should have another two or three months to think over the matter. His own view was that they ought to try and pull it round themselves. If it was worth Mr. Gwynne's while, or that of Sir Rawson's son, to buy the business, it should be worth the while of the shareholders themselves to stick to it and bring it round.

Mr. Whately said he would briefly remind the shareholders of the position since March last. At that time the directors suggested to the shareholders the advisability of finding more money to carry on and extend the business. The shareholders did not fall in with the directors' views. He would pass over the intervening period. After that Mr. Gwynne's offer, which would have given them about 4s. per share, was obtained by the directors. Before that offer was submitted, they had had a committee, they had advertised for tenders, and had done everything to get rid of the business. But nobody offered anything for any part of it except Mr. Gwynne. His offer was accepted at a meeting of the shareholders, but afterwards proceedings were taken whereby the further progress of the arrangement was stopped. Mr. Gwynne withdrew his offer, and the matter came to an end. Since then absolutely nothing had resulted from their efforts to dispose of the business. These facts were laid before them at the last meeting on the 23rd of November, and it was then moved and carried that the directors take steps to go into voluntary liquidation. If they went into voluntary liquidation now they might get something back; if they deferred the matter for another three months they would get nothing, and if they put it off for six months they would have a call to pay. It was quite clear that they were a disunited family, and there was no use in going on under these circumstances. As to the suggestion to dispense with the central management, they could not do it. They might in private business entrust everything to their managers, but whilst they were a company they must conduct their affairs upon company methods. The directors, by stopping on, could not do a bit better than the liquidators, and as long as they kept them on so long would they have the £1,000 a-year to pay.

The Chairman: Do I understand that Mr. Fellows makes a proposal?

Mr. Fellows: Yes. I propose that this question be deferred for two months.

Mr. Fyfe seconded. He said that as he thought he had instructions to look for a customer, he had accordingly looked for and found one; but when he took him to the factory he failed to get permission to inspect it for a very long time. He had letters and verbal messages from the secretary to the effect that he (Mr. Fyfe) had no authority, either from the shareholders or from the directors, to sell the business. The customer was choked off because of the unwillingness of the directors to sell through him, or even to sell at all. Notwithstanding that he (Mr. Fyfe) was still negotiating with different people. He had no objection to their going into voluntary liquidation, because that was a necessary thing to do, provided due precaution was taken to ensure that all offers should get fair consideration from the liquidators. There should be control of some kind so as to make sure of that, because there was to some extent a lack of confidence, and a feeling that the thing was to be sold in some hole-and-corner way.

If the liquidator was a thoroughly independent man he believed he could even yet bring forward a better offer than that of Mr. Gwynne; but it would not be done without fair and honest consideration.

Mr. Whately: But you have brought us no sort of offer for consideration.

Mr. Fyfe: Because you choked off the people I did bring. You never gave me the proper authority. Then it was a matter of commission. You said that was never agreed to or spoken of.

Mr. Whately said they told Mr. Fyfe that they would be very pleased to submit to the shareholders any claim for commission he thought proper to make, but that they had no power to promise him any commission.

The Chairman said Mr. Fyfe wanted a written authority to sell, and stating that he was to receive 10 per cent. commission. The directors answered that he could have no authority to sell; the sale rested with the directors, who would be glad to receive any offer through him, and to recommend him for adequate remuneration; but they had no power to give him 10 per cent.

Mr. Gwynne said that when Mr. Fyfe brought his action to restrain the sale to him (the speaker), he stated on oath, and it was also strongly insisted upon by his counsel, that the sum at which the directors had agreed to sell was utterly insufficient, and he begged the Court to interfere. Now he (Mr. Fyfe) came forward, after—not two months, the time he had asked for, but four or more months, and coolly told them that even now he thought he could get somebody to come forward and give the sum Mr. Gwynne had agreed to give. He asked any clear-headed, single-minded man, what justification had Mr. Fyfe for going before the Court and making affidavits that he was in a position there and then to obtain an offer of a sum which now, after many months had elapsed, he was not in a position to bring forward?

Mr. Fyfe: He is in a position. I have had responsible people willing to buy, and they have simply been stopped by my having no authority.

Mr. Rawson reminded Mr. Fyfe that he had said that he thought voluntary liquidation necessary. It seemed to him that that was the difficulty formerly, the directors having tried to sell without going into liquidation. He thought they had given ample time to Mr. Fyfe to get the customer he had spoken of. He (Mr. Rawson) was strongly against their allowing compulsory liquidation to be forced upon them. It was extraordinary that the customer Mr. Fyfe spoke of, if he wanted to buy, did not go to the people who wanted to sell.

Mr. Fyfe: He went to the secretary.

The Chairman: One of the requests of this customer was that we should fix a price, and that we were not prepared to do.

Mr. Fellows's amendment that the meeting should be adjourned for two months was then put and negatived. The original resolution was carried by nine votes to three.

Major Scriven said that now the resolution was carried, he would like to say a few words. A great deal of what had been said by Mr. Fellows was very valuable, and he agreed with him that much of the company's property was of considerable worth. He, for one, should try to bring an offer, through some friends of his, to the liquidators, and no doubt they would all wish to do the best they could in that direction for their own sakes. The directors would have been very willing to go on, if they could have got rid of the difficult element. With regard to the statement of Mr. Fyfe that the directors had thrown obstacles in his way, they had tried throughout to see in what way Mr. Fyfe could be of benefit to the company, and had utterly failed; he was impracticable. They were anxious to get rid of the business, and if Mr. Fyfe would only bring forward an offer, he would be welcomed,

The Chairman moved "that Mr. George Shead, of 9, Laurence Pountney Hill, Cannon Street, chartered accountant, and Mr. W. H. Trentham, of 4, Stanhope Street, Euston Road, engineer, be and are hereby appointed joint liquidators for the purposes of such winding up.

Mr. Whately, in seconding, said that the reason why the auditors were not proposed for the liquidators, was first, because Mr. Akers might possibly bring an offer for the patents, and also because they did not care to undertake the work at a fee for which the directors thought they could get it done. Mr. Trentham (the secretary) and Mr. Shead were both well known to him, and he was perfectly satisfied to entrust the matter to them. They had agreed to carry out the work for 50 guineas each, which he thought was extremely moderate.

Mr. Fellows: I wish to move an amendment to the resolution, that an official liquidator be appointed.

Mr. Garrod (the solicitor): You can't move that.

The Chairman put the resolution, which was carried by nine votes to one. Mr. Fellows remarking that he had no personal objection to the liquidation, but he objected to the principle of the shareholders and directors surrendering all control over the business.

A vote of thanks to the chairman terminated the proceedings.

Swan United Electric Light Company, Limited.

THE sixth annual general meeting of this company was held on Tuesday at the Cannon Street Hotel, E.C., under the presidency of the chairman (Mr. J. S. Forbes).

Major S. Flood-Page, the Secretary, having read the notice convening the meeting, the report and accounts were taken as read.

The Chairman said the few small entries in the profit and loss account made up really the kernel of their nut. The most important of them all was the sales, less commissions and allowances, £40,126 6s. 10d.; that showed a considerable advance in the volume of business compared with the previous year—about £13,000 in round numbers. The transfer fees and interest account was about £330 less, and that interest they would see was derived chiefly from investments of cash in consols and other securities. Stock, £9,676, was £1,450 in excess of the corresponding year, so that those two added together—what they had sold and what they had made and put away—represented £14,450 more in volume of business than they had last year. Turning to the other side of the account, the stock carried over amounted to £8,221; purchases, £17,238—that was a compound item, embodying the material necessary to manufacture the large number of lamps that had been sold, and also including a considerable amount representing lamps which this company had been obliged to buy of the company in England, in which they were so largely interested, the Edison and Swan Company. Then there were office expenses, directors' fees, rent, salaries, &c., £3,916; Mr. Swan's salary (less proportion payable by the Edison and Swan Company), £400; wages and expenses at factories, £11.922; depreciation, £1,079; and then the balance, £8,332. It would be seen that it was only £780 in excess of the balance of the preceding year. The one happy feature about it was that the £8,332 was unencumbered by a claim for previous losses. In the corresponding year they had to reduce by between £7,000 and £8,000 the profit they had made by writing down an amount outstanding against the accumulated losses of previous years, and that reduced the balance carried over to £1,720. Now the £8,332 for this year was unencumbered by any such claim, and was transported bodily into the balance sheet. But proprietors would naturally ask how it was that, having done £13,000 more business, they had only got £780 more profit. Well, he must tell them that competition was going on rather severely on the Continent—probably not quite so severely now, since they had themselves become members of a considerable continental company; but still it had gone on, and the directors had thought it prudent to meet that competition by, in fact, bending to the storm of it, and reducing somewhat materially the prices of the lamps, so that they had sold a larger number of lamps at a less price per lamp. They had taken, in fact, what they could get for them. That was one reason. Another was that in the valuation of the stock taken forward they had been a little more severe against themselves this year than in the preceding year. They took over the stock at a higher figure last year than they had done this; and they had thought it prudent—being more anxious for the permanent foundation on which their business was to rest than the profit of a particular year—they had thought it prudent, in face of the great competition to carry forward the stock at a less price than they had done hitherto. That had made a material difference in that figure. They might have carried forward the lamps at a price even £3,000 greater than they had, but in face of the competition they had thought it wiser to carry forward the lesser sum. If they were able to get rid of them at anything like the price of last year, they would have a better result to show the shareholders in the next balance sheet; in fact, it was a case of holding the bird in hand. In the balance sheet things remained pretty much as they were. The share capital was about the same; they had recovered the munificent sum of £2 10s. from somebody whose call was in arrear, but that did not materially disturb the state of the capital. Sundry creditors were £2,943, which was about £2,000 less than in the corresponding year; then the balance on September 30th, 1887, was £1,720, which was what remained of gross balance last year after deducting the claim which he had described as the accumulating losses of previous years. They now stood credited in the balance sheet with £10,052. On the opposite side of the balance sheet they would see cost of patent rights at exactly the same figure. On the formation of the Compagnie Générale des Lampes Incandescentes, as he explained at the extraordinary meeting held not very long ago, they had to expend a further sum of £930 on those patents by the agreement with their French competitors, but they had now become a portion of the company having its seat in Paris, and, having got rid of the litigation, were putting their shoulders together with a view to building up a business. That company appeared in the balance sheet for 800 shares, which they had to take over as an equivalent to their share in the new company; the patent they put in. The £930 was largely made up of this: When a company in France transferred into a new company it had to pay up all the accruing patent fees for the years unexpired. That absorbed the greater part of the £930, and the rest was made up by the legal expenses for drawing the important agreement into which they had entered. Then there was £15,838, representing the 800 shares of 500 francs each, which they got as their proportion of the capital of that company, 1,000,000 francs representing the patents which both companies put into the common pot. Last year, having an unsettled account with respect to the Lille factory on hand, they carried £3,000 to a special reserve. The Lille factory was now wound up, and they had brought the £3,000 from the reserve into this account, to the value of their outlay on factories and plant, which brought that item down to £5,396. Then they had carried against themselves the usual amount of depreciation, so that out of revenue, the outlay on factories, plant, &c., had been diminished to £4,317. They had got rid of the Lille factory, and the only factory on hand was the Kalk factory, near Cologne, on which a considerable amount of money had been spent, and which it was necessary to maintain, as there was a difficulty of carrying on the business in Germany, the law requiring that a patentee should produce in that particular country. That was put at

£4,000; they had spent, perhaps, two or three times £4,000, but had written down year by year large depreciations, and 20 per cent. in five years would, of course, wipe out the whole thing. The directors contemplated being able to carry out the same arrangement with regard to Germany as they had in most parts of the Continent—to fuse the two interests on some terms or other, as he explained at the meeting for carrying out the fusion with the French Company. Arrangements for this purpose were on foot, and would shortly be prosecuted. If that were carried out they would make their bow to the manufactures of Germany, and probably on the condition that their successors took over the Kalk factory at a valuation which he hoped would considerably exceed the £4,000. Then came the *bonne bouche* of the company, the shares in the Edison and Swan Company. That remained, of course, unaltered, £208,478; next, the shares in the Compagnie Générale des Lampes Incandescentes, £30,489, £15,838 of which represented the value of the shares for the patents they brought in, and £14,651 the value of the 740 subscribed shares, meaning, in fact, the subscription capital of both companies to start the business in France—that made up the £30,489 which they had got in that company, Well, he was not going to prophesy, but their French colleagues, when they were over in Paris the other day, were very sanguine that it was a very good investment, and that the day was not very far distant when there would be a considerable, or at all events, a fair profit on that outlay. They would see there was not an inconsiderable sum in the character of cash, or what could be turned into cash at any moment if they wanted it for the extension of their business—about £40,000, and that invested would bring in a moderate amount of interest for the benefit of the profit and loss account. Coming to the report, the two first paragraphs embodied all he had told them. The shareholders were reminded of the agreement with the Compagnie Continentale Edison, which was approved by an extraordinary meeting on June 5th last, and was also approved by those who had become their partners; all the legal formulary had been carried out, and the company was on its legs. The factory was designed by their friends in London, the French Company being kind enough to give them credit for having more knowledge of what would be useful and desirable than themselves, and to accept their views as to the class of factory, machinery, and so forth, to be installed there. Meanwhile they were supplying them with lamps from Germany and partly from this country, until they were in a position to manufacture for themselves, which would probably be in February or March next. As to Germany, he had told them he hoped to bring the litigation to an end; that turned upon whether the negotiations now going on were successful—whether they could be induced in Germany to follow the lead of those in France, and putting their horses together extend the business under both patents combined. The directors had been most anxious for two or three years to get rid of the litigation, and do that which had proved a wise thing in this country, and he thought would be wise there. There was one thing more to which he would draw their attention —what were they to do with the £10,000? Naturally, he should like to draw a little of it as interest on what he held in the company; but it appeared to the directors that it would not be prudent at present to distribute it, for the same reason that in the Edison and Swan Company, where the balance was much larger —about £25,000—it was thought wiser to carry it over for a time. Their litigation in Germany involved the possibility—he was not going so say how remote it was—but it involved the possibility of their being landed in damages, and it would hardly be prudent to be parting with a fund out of which those damages would be fairly met if they arose. Another reason for this was that this company was an English company, and they were advised that it was forbidden by the law to distribute a dividend where there was a wasting quantity, such as the cost of patent rights, as per last balance-sheet. They had got rid now of that portion of the patent rights which affected a considerable portion of Europe, but there was a certain residuum in Germany, India, the Cape, and some outlying places, to which it was quite impossible to attach, in a concrete form, any apportionment of the £105,000— now reduced to £90,000 by the sale of a portion of those patents in France. They could not say that in Germany, in India, or in some other places the patents were worth £30,000. But while that £90,000 remained in their balance-sheet they were advised that they could not distribute a dividend, and being thus advised they would, of course, be exceedingly rash to attempt to distribute it. These patent rights had a certain term to run, and what they were trying to do in this company, as well as the Edison and Swan, was to utilise that period in the improvement of the lamp, so as to have the production of the very best article, and in the extension of their connection. He was prepared to recommend the proprietary to do one of two things, or both, or partly one and partly the other. Out of any exuberant profit let them put aside a portion, and also consider whether it would not be a wise thing to do what the courts would allow them to do—reduce their capital. Writing down the capital was a purely theoretical thing. It did not matter to them whether their shares represented £3 10s. paid up, £3 paid, or £2 10s. paid, if the holders of those shares were entitled to all the profit made. It was simply a question whether they should have 5 per cent. on one figure, or a larger percentage on a larger figure. If it were seriously proposed they would have to have an extraordinary meeting of shareholders, and they would then be asked to make up their minds whether it would be a prudent thing to do. He moved, "That the report of the directors and accounts for the year ended September 30th, 1888, be received and adopted."

Mr. F. R. Leyland (deputy chairman) seconded the motion.

There was no discussion, and the motion was then put and carried unanimously.

Mr. Swan was re-elected as director, the vacancy created by the retirement of Mr. Stearn being left open.

The re-appointment of the auditors, Messrs. Quilter, Welton and Co., having been carried, the proceedings terminated.

Electrical Automatic Delivery Box Company, Limited.

AN extraordinary meeting of the shareholders of this company was held at the Cannon Street Hotel on Tuesday, the object being to appoint new directors, and pass other resolutions to enable the company to carry on the business. Mr. A. H. Deakin presided.

The Chairman said the first question, the most vital question, they had to decide was as to the merits of the automatic box. If, after testing it, they were not satisfied with it, it was not much use going on, and the sooner Messrs. Trimmer & Co., the petitioning shareholders, got their order and the whole affair went into liquidation the better. Mr. Michael Abrahams, who had recently been appointed solicitor, would explain the legal position of the company.

Mr. Abrahams: My firm was called in to advise the directors on December 6th. The previous solicitors of the company had been Messrs. Pike and Minchin, whose names appeared on the prospectus. When we were called in this was the position of your affairs. A petition had been presented by three shareholders asking for the winding up of the company. The solicitor to the petitioners placed himself in communication with me, and said his clients wished to have some independent report. On that, Mr. Ingrey was asked to thoroughly try the box, and report. It was expected that his report would be here to-day, and, no doubt, it will soon arrive. In the interests of the shareholders the directors had called a meeting of the shareholders to pass resolutions to wind up the company. They tell me their object was not to destroy the company, but to wind it up with the purpose of reconstructing it. I saw that, if there was a meeting the day before the petition, the company would be wound up, and your property destroyed. I therefore took upon myself to advise the directors to revoke the meeting, and inform the shareholders that it would not be held. They said they were prepared to place their resignations in the hands of the shareholders, and the shareholders could say whether it was worth while to go on with the company. That was done, and when the petition came before Mr. Justice Kay he was informed that you were meeting to-day to decide what was to be done. He at once said: "It is a matter for the shareholders. I will do nothing until the shareholders have decided whether they will go on. It is their property, and they must decide." Well, gentlemen, you are here for the purpose. The question you have to decide is whether the company shall go on. Those who received the prospectus will see that the price paid for the machine was to be £10,000 in money and £20,000 in shares; that is £30,000 in all for the machine. I advised the directors that that was an excessive price; in fact, the company could not prove a financial success if they had to pay that price. There has been a consultation with the vendors as to whether there should not be a reduction, and I have myself been conducting the negotiations. There are two parties who have claims, the patentees (Messrs. Villiers-Stead and Hedgman), and the other, the Contract Corporation, who are now in liquidation. As regards the patentees, they have agreed to receive £2,400 in shares beyond what they have received already on the assignment of the patents. The Contract Corporation are in liquidation, and a liquidator has not yet been appointed. He will not be appointed until the first week in January, but the person proposed has had many conferences with me on the subject, and I have no doubt he will be satisfied, if it is possible to make this a success, to receive a similar amount of shares to the patentees. You will then have a capital of something like £1,500. The next point to consider is if you have enough money to work the machine, and give a profit on the capital. The directors inform me that they have in hand a sum of £15,000 remaining from the various calls. That sum is on deposit at the Bank in perfect safety. Besides that there are calls unpaid, and the total capital will be something like £4,000. The question is, is that sufficient to give you a good dividend upon a capital of £15,000? These are all questions for your consideration. The advice I give is to ask you to form a committee amongst yourselves to confer with the directors to see if all these arrangements are carried out, and see if it can be made a success, so that you may carry on your own business for your own benefit.

The Chairman, in answer to questions, said the cost of each box was £12. They had a dozen of them; but if they gave an order for two or three hundred they would get them cheaper. With the money in hand they could have 300 boxes, and at the estimated net profit of £10 a year, it would show a very handsome result, and pay good dividends on the reduced capital.

A Shareholder: Is it true the company have returned to one shareholder his subscription in full?

The Chairman: No, it is not correct. The gentleman brought an action against the company for the return of his money, and, on the advice of Messrs. Pike and Minchin, it was settled in a very satisfactory way by paying a sum of £100 on 150 shares, and removing the gentleman's name from the register.

The Chairman then read the report from Mr. Ingrey, who said, in the course of it:—"I very carefully examined and

tested this machine, and I express the opinion that it has been very cleverly thought out and is certainly effective. There are, however, some points of construction which will require to be considered in manufacturing these machines, and I will be pleased to enumerate them if requested. If suitable articles are selected for sale by these machines, at prices ranging from 2d. upwards, I think the electrical automatic box is the best apparatus I know for the purpose, because it enables a combination of coins to be used, which is not possible by any mechanical machinery I am acquainted with."

The Chairman, in answer to further questions, said 7,000 shares were subscribed for by the public, and 100 each by the directors. The vendors entered into certain under-writing arrangements, and obtained applications from friends, which, in view of the large reduction in price, they said now it was not worth while carrying out.

Mr. Stead: Allow me to say the vendors are not the patentees. We never gave any guarantees. All we have received in cash has been £1,100. We had confidence enough in our own invention to invest cash in it. We paid £450 for 600 shares, so that the only money we have received is £1,100. We know that Mr. Ingrey tried the machine to the best of his ability, and could not find any fault whatever. For instance, if a man went to a three-penny machine and tried to get an article for twopence, it would cost him fourpence to get it. He tied a piece of string to a coin and tried to get it back again, but could not. He tried every possible means, but was not able to take advantage of the machine. It is the only machine that will take pence, halfpence and farthings, and any kind of money.

Major Murdoch proposed that the directors be asked to resume their functions at the board and try the company for another year.

Mr. Huntley seconded.

Mr. Reeve proposed that, the directors being so few in number, the following be appointed a committee to confer with them on the subject of the management and working of the company, viz.: —Mr. J. T. Evans, Major Murdoch, and Mr. Booth, who were all three considerable shareholders, and that they report to an adjourned meeting of the shareholders, to be held at an early day, say January 9th.

Mr. Bruce Jones seconded this amendment, which was then put and carried unanimously, and the meeting was adjourned to January 9th, after a vote of thanks to the chairman had been accorded.

Maxim-Weston Electric Company, Limited.

AN extraordinary general meeting of this company is to be held at the Cannon Street Hotel this afternoon, when the subjoined resolutions which were passed at the extraordinary general meeting of the company, held on the 3rd day of December, 1888, will be submitted for confirmation as special resolutions.

1. That the Maxim-Weston Electric Company, Limited, be wound up voluntarily.

2. That Mr. John Marks, of 113, Great Russell Street, W.C., Mr. J. M. Klenck, 42, Bishopsgate Street Within, E.C., and Mr. Louis Swaby, of 23, Churchfield Road, Ealing, be and they are hereby appointment liquidators for the purpose of such winding up.

Upon the conclusion of the confirmatory meeting, a second extraordinary general meeting will be held, when the following resolutions will be proposed as special resolutions:—

1. That the liquidators of the company be and they are hereby authorised to consent to the registration of a new company to be named the Maxim-Weston Electric Company, Limited, with a memorandum and articles of association which have already been prepared with the privity and approval of the directors of this company.

2. That the draft agreement submitted to this meeting, and expressed to be made between this company and its liquidators of the one part, and the Maxim-Weston Electric Company, Limited, of the other part be and the same is hereby approved, and that the said liquidators be and they are hereby authorised, pursuant to Section 161 of the Companies' Act, 1862, to enter into an agreement with such new company (when incorporated) in the terms of the said draft, and to carry the same into effect with such, if any, modifications as they think expedient.

Anglo-Portuguese Telephone Company, Limited.—Coupon No. 2 of the 6 per cent. debentures, due January 1st next, will be paid, less income tax, on and after that date by the Alliance Bank, 2, Bartholomew Lane, E.C.

Telephone Company of Austria, Limited.—Coupon No. 6 of the 5 per cent. debentures, due January 1st next, will be paid, less income tax, on and after that date by Messrs. Martin and Co., 68, Lombard Street, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 14th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,695.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th December are £2,790, as compared with £2,807 in the corresponding period of 1887.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending December 14th amounted to £5,627.

RULES AND REGULATIONS FOR OVERHEAD CONDUCTORS FOR ELECTRIC LIGHT AND POWER.

THE following are the complete rules and regulations recently issued by the New York Board of Electrical Control:—

I. No two lines of poles bearing conductors of a like class shall be erected on any street or avenue.

II. No two lines of poles shall be erected on the same side of any street or avenue.

III. Poles shall be set in the sidewalk 12 inches from the outside of curb, and no pole shall be placed within 10 feet of any lamp-post or other pole, except at street corners where necessary in order to support wires running on the cross street.

IV. All poles now standing, or to be hereafter erected, shall be branded or stamped with the initials of the company owning them, at a point not less than five nor more than seven feet from the street surface; and when a pole is occupied by wires belonging to more than one company, each group of cross-arms, or where necessary the support of a single wire of different ownership, must be distinguished by some characteristic paint, mark or fastening.

V. Electric light lamp-posts shall be in accordance with the plan adopted by the board.

VI. All poles erected for the purpose of carrying lines of more than two electric light or power wires shall be at least forty-five feet high, uniform in size, straight and painted from top to bottom—a very dark colour from the sidewalk to a point eight feet high, and a dark green colour above that.

VII. All poles for carrying not more than two electric light wires shall be twenty-five feet high, straight, uniform in size, and painted from top to bottom—a very dark colour from the sidewalk to a point eight feet high, and a dark green colour above that.

VIII. Cross-arms shall be uniform in length, strengthened by braces, and painted the same colour as the poles; the cross-arms of each company being distinguished by some characteristic mark.

IX. Each line of poles must be run on one side of the street only, except when absolutely necessary to change to the other side; but this may only be done by the permission of the board or of its engineer or expert.

X. Electric light conductors must not be placed upon fixtures erected or maintained for supporting wires of the other class, namely, those for signalling, except by permission of the board.

XI. Poles shall be uniformly spaced, and about sixty to the mile. This requires on the short city blocks of 260 feet, alternately three and two poles to the block.

XII. All conductors shall be secured to insulating fastenings, and covered with an insulation which is waterproof on the outside and not easily worn by abrasion. Whenever the insulation becomes impaired it must be renewed immediately.

XIII. No wire shall be stretched within four inches of any pole, building or other object without being attached to it and insulated therefrom.

XIV. Every wire must be distinguished by a number plainly marked on each cross-arm under the insulator.

XV. No unused loops from electric light circuits shall be allowed to remain after lamps are taken away, except in cases where it is positively known that the lamp will be required again within three months, and where there is no underground conduit for that class of circuits.

XVI. All arc lamps must be so placed as to leave a space underneath of nine (9) feet clear between lamp and sidewalk.

XVII. All wires must be stretched tightly and fastened to glass or porcelain insulators, approved by the expert, with a strap of the same kind of wire.

XVIII. All connections with lines of electric light conductors shall be made at right angles to the same; and connections to buildings shall be run straight across to the building and then down the front of the building.

XIX. All joints must be as well insulated as the conductors, and the insulation of joints shall be maintained.

XX. Every line entering a building shall be controlled by a cut-off, placed near the entrance, in sight, and easily accessible.

XXI. No wires shall hang within twenty feet of the pavement at the lowest point of sag between supports.

XXII. In the construction of lines the insulation to be used must be approved by the expert of the board in writing, and the insulation resistance must be maintained in accordance with a standard to be not less than $\frac{1}{10}$ megohm per mile per hundred volts. And under no circumstances shall underwriters wire be used.

XXIII. All circuits must be tested every hour. and when a ground comes on, effort must be made to remove it at once. Failing in this, the current must be discontinued until the insulation is restored.

XXIV. The insulation must be preserved throughout the entire circuit, and if any portion of a lamp or fixture is a part of the circuit, and can be touched, it must be insulated.

XXV. All conductors shall have a resistance, uniformly distri-

buted, of not more than 30 ohms per mile per ampère, and proportionately less for heavier currents.

XXVI. All existing regulations of the local authorities in regard to the placing of poles and stringing of wires are to continue in force, except when in conflict with these rules; and the rules and regulations of the New York Board of Fire Underwriters must be strictly observed.

XXVII. The violation of any of the rules and regulations of the board shall operate *ipso facto* as a revocation of the permit held by the company or person guilty of such violation.

XXVIII. Whenever hereafter any company shall be permitted by this board or its successors to erect posts or poles, or other fixtures bearing lamps or other devices, for the purpose of lighting by electricity the streets, avenues, highways, parks or public places of the city, the said permission shall be granted only subject to the following provisions, and the same is hereby expressly made a condition of said permits. At any time when, by action of the city authorities, the contract for lighting any such street or other public place shall be given to another company, the company erecting said lamp-posts shall, on tender of the first costs thereof, yield possession and ownership of the same to the said other company obtaining the new contract, except in cases where the company owning the lamp-posts prefers to remove them.

XXIX. All broken and "dead" wires, and all wires, poles, and fixtures not actually in use—subject to rule XV.—must be removed from the streets, avenues, and highways of the city. When an old pole is taken down it must be removed from the streets the same day. New poles must not be brought upon any street more than two days in advance of their erection. Any pole that shall lie on any street more than two days shall be removed by the Bureau of Incumbrances of the Department of Public Works, at the expense of the party owning it.

XXX. From and after January 1st, 1889, no company shall do business of arc electric lighting in the city of New York without a certificate of the board, granted on the recommendation and after inspection by the expert of the board, to the effect that its lines comply with all the rules and regulations of the board, and that its plant is in proper condition for the doing of its business. The force of the certificate to continue until changes are made, of which the board must be notified and approve, or so long as the plant and conductors remain in the same condition as when inspected.

XXXI. Every lineman must wear a badge in a conspicuous place, giving his number and the name of the company by whom he is employed.

XXXII. All permits of the board for overhead wires and fixtures are granted only pending the providing of underground accommodations in the neighbourhood of the street or avenue for which the permit is granted.

XXXIII. Any member or officer of the board, and every inspector employed by it, as well as every member of the police force of the city, shall be entitled to examine permits under which work of any kind is being done.

XXXIV. No permit shall be granted for the erection of any overhead structure nor for the renewing of any lines already existing in any street, avenue, or highway in which underground accommodations for the service have been provided, or are being provided.

XXXV. Every line, pole, fixture, &c., must be kept in thorough order, repair, and conformity with these rules and specifications, upon penalty of forfeiture of all permits granted to the owner by this board. But the general permit under which these repairs are to be made does not cover the erection in any street, avenue or highway of any new poles or other similar fixtures, and has absolutely no reference whatever to lines which have been ordered underground by the board, and which the Mayor has been requested to remove. In the case of such lines, where notice has been given that underground accommodations have been provided, and the 90 days of notice required by law haveelapsed, and the Mayor has been requested to remove the same, companies owning or operating said lines are not authorised to make any repairs or connections, or to go upon the poles bearing such lines *for any purpose whatever*, except to remove the said lines of electrical conductors in conformity with the directions of the board. Any deviation from this rule requires a resolution passed at a regular meeting of the board, attested by the secretary.

XXXVI. Every company or person erecting poles, wires or fixtures must make and leave, at least once each week, at the office of the board, such records of the fixtures, &c., which they are erecting, and of all of the same that they have in use, as are required by the engineer and the electrical expert of the board, and in such form as shall be prescribed by them.

XXXVII. The companies or persons owning or controlling poles in any street or avenue, erected under permits of this board or the Board of Electrical Subways, shall allow the same to be used by other companies or persons operating conductors for similar electrical service when authorised so to do by the board, on tender of proper compensation, to be determined by agreement between the parties interested. In default of such an agreement, the amount of such compensation shall be determined by the board. This rule imports a contract on the part of each company or person owning or controlling the poles on any street or avenue, not only with the board, but also with each company or person who shall, under its terms, be qualified to demand the privileges it confers, to permit this joint use of poles. And in accepting any permit, the applicant thereby binds himself to this agreement.

COMPOUND-WINDING PATENTS.

KING, BROWN & CO. *v.* ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

(*Continued from page* 678.)

Thursday, December 6th.

The case was resumed on Thursday forenoon before Lord TRAYNER, and the re-examination of Professor PERRY was proceeded with by Mr. GRAHAM MURRAY.

I suppose Varley's machine as it stands [machine in court] might quite well be used as a series shunt machine?—Not as it stands; it ought to be connected up.

Will you not say that that would be a natural way of connecting that machine—the series shunt?—Perfectly natural to me now.

If you were told that that machine was used with a lamp such as this—the Serrin lamp—and that when the lamp was lighted the magnetism of the machine was observed to greatly increase from what it was before the lamp was lighted, would that show you that the machine had a coil which was working in series?—It would show me it had a coil working in series, probably.

Why not necessarily?—I could not say necessarily. In all probability.

You see the hypothesis I put to you is that the magnetism of the machine was observed to increase just as the lamp was lighted. The lighting of the lamp is the closing of the electric circuit. Does it therefore not show that the magnetism of the machine is increased by means of the electric circuit in which the lamp is?—Yes.

And if the magnetism increased by means of the electric circuit in which the lamp is, how could it be except by a portion of the coil going round the magnets?—In this short time for consideration, I know of no other way.

Take from me next that when the lamp was not lighted there was considerable magnetism observed in the machine, as evinced by sparking at the brushes, and by actual magnetism being felt by keys, would that indicate that there was magnetism communicated to the machine either by shunt circuit or by a separately excited circuit?—It may mean either, or something else.

What is the something else? Is there anything else?—The permanent magnetism of the machine itself.

Wrought iron, I think, is not a permanent magnet?—In any case there would be a residual magnetism, and if those ends are cast iron there would be a good deal. Residual magnetism would produce sparking.

Witness examined the machine, and found by chipping the ends with a chisel that they were of wrought iron.

Being wrought iron, it is soft iron. Don't you agree that in a machine constructed of soft iron, the residual magnetism would not show its presence in any way except at the start of the machine, and would be very small?—Comparatively small.

If it was noticed that the magnets were excited before the lamp circuit was closed, and that that was seen by holding tools or keys towards them, would not that be strongly indicative of either a shunt coil or a separate excitation?—Yes.

Now with the commutator as it at present is, and these diagonal connections, there could not be, I think, separate excitation without altering these connections?—These connections are made to alter.

Coupled as it is at present, it could not act by means of separate excitation?—No, coupled as it is now. It is coupled now as a series machine.

Or as a series-shunt?—You cannot say it is coupled as a series-shunt unless you see the connection with the magnets.

As far as its connections with the commutators are concerned?—Yes.

The idea of this machine being pure series is inconsistent with the second coil, is it not?—Yes.

So that, if not coupled series-shunt, the only other way to use the other coil would be for separate excitation?—Yes, probably. It might be a shunt from the outside circuit.

Of course, that would be a shunt circuit, would it not?—A shunt circuit not to the machine but to something quite outside of the machine.

Witness sketched a diagram illustrating his view, but under examination acknowledged it did not show a series arrangement at all.

Is the commutator of that machine cylindrical?—It is of a cylindrical shape.

And do you think its segments are detachably attached?—Not except with violence.

Don't you think they could be taken off with ordinary tools?—No, it would have to be done with violence; it was done with violence.

His LORDSHIP: Could it be done without violence?—Perhaps it might, but I can hardly think of any way without prising them off.

Mr. MURRAY: Could not you drill the screws off?—You could.

In Brush's commutator you find, do you not, that the segments, T, need not be of metal, or, in fact, of any insulating material at all, but may be represented by an omission?—The arrangement always was of metal.

Witness read the specification and found that the segment could be represented by a space.

The object of the spaces is to cut the armature out of electrical connection at or about the neutral point of the revolution?—Yes.

That is a useful object, I suppose?—Yes, it was well known to be a useful object.

Look at claim 6, page 16, line 30:—"A commutator having two conducting segments, s, the opposing ends of which segments are separated by an insulating segment, T." It would be possible, wouldn't it, to make the commutator there claimed according to the alternative which I showed you upon page 10, line 45—that is to say, to make T a mere space?—Well, if that T is the same referred to in 45—which I didn't think of till now—yes.

Well, there is only one T in the alphabet, professor. (Laughter.) Do you find any indication of that in the provisional specification?—Of what; of a wearing segment?

No, of an insulating segment, which is not a wearing segment?—No, I don't think so.

The model (produced) is merely meant to represent the winding of the field magnets. Isn't that model series-shunt winding?—If the commutator is arranged as shown in fig. 17 I think it would be so.

Taking that model and asking any man how those field magnets were worked, wouldn't he say "shunt wound"?—Yes, I think so.

By the DEAN: What meaning do you think a workman would attach to the word "divert" in 1876?—To divert the electricity, taking it the idea of separate circuit excitement was meant and not bifurcation.

Do you say that it is possible to reconcile one with another all the passages and sentences in Varley's specification?—No, certainly not.

Is part of your objection to Varley's specification as a prior disclosure that it would form a puzzle to any electrical workman seeking to construe it?—Yes.

What in your view would be an arrangement which would make the nearest approach to a reconciliation of the different passages?—I think separate circuit excitement.

As used by Wilde, or as suggested by Varley himself in his 1867 patent?—As suggested in the 1867 patent: an improvement on Wilde.

Diagrams were put in by defenders showing the system of separate excitation from within the machine and separate excitation from an external source.

Could you construct a machine that would work when you had an odd number of loops and bobbins with an even number of magnets?—No; one does not see how you could have it with a working machine.

Unless you devoted one of the odd number to separate excitation?—Yes.

Does not the passage on page 9, line 19, refer to the springs being connected from one spring to the other spring through the metal disc of the commutator?—Yes.

That being so, that does not suggest that the commutators are connected in series with one another?—It says the brushes.

Does it merely suggest the connection of the one brush with the brush on the opposite side?—It says the brushes are connected.

Across the end of the same commutator?—Probably across the end of the same commutator, it may mean.

Your view is that fig. 17 shows a simple series wound. In page 10, line 52, it is said in describing fig. 11, of which fig. 17 is the commutator, that the magnets are arranged in line with the bobbins. Is that conclusive as to the simple series arrangement being in view?—He is there speaking of a two pole machine, and the commutator shown is of a simple series machine.

Is the passage consistent with anything but simple series winding?—That is consistent, I think, only with the simple series winding.

Do you say the same of the passage on page 11, line 52?—I don't think it excludes every arrangement, but it points to the series arrangement.

By Mr. MURRAY: Fig. 11 shows the mechanical arrangement of the magnets and bobbins in a two poled machine.

And has nothing in the world to do with how the field magnets are worked?—Except that it refers to fig. 17.

His LORDSHIP: Apart from the question of fig. 17, and what it may say, is there in this passage on page 10, lines 50-2, any reference whatever to the mode in which the magnets are worked?—No.

ALFRED HICKS, overseer of the Graphic Illustrated Newspaper Companies' Electrotyping Company, said that in the spring of 1883 his firm purchased a dynamo from the Anglo-American Brush Company. It had been put to work on electrotyping and had been working ever since. During the five years there had been no difficulty due to reversing of the poles of the machine.

By Mr. MURRAY: The machine worked on copper. Nickel, he was aware, had a greater tendency to reverse than copper.

Professor Sir WILLIAM THOMSON, Glasgow, examined by the DEAN OF FACULTY, stated that since 1866 he had been engaged in practical electrical engineering—since the laying of the first Atlantic cable, 1866-7-8—and was familiar with the various types of dynamo machines which had been in use during the period.

I shall ask you, generally, whether the Brush arrangement—series-shunt winding, in other words—was, in your opinion, a marked and valuable improvement upon previous arrangements?—It was so.

In particular, was it a valuable improvement upon the shunt?—Yes.

And upon the series?—Yes.

And is the description in the Brush specification such as would enable an ordinary workman to obtain the benefits of the invention without any difficulty?—Yes; it is quite clear and complete, and well illustrated by drawings.

Was the shunt arrangement known and practised at the date of the Brush patent?—I don't think it was known and practised. Indeed, I have reason for saying so, because I heard of it first in consequence of Siemens's communication in 1879. I believe I had myself the very first practical shunt machine for electric lighting. I got it from Siemens with some difficulty. The series arrangement, I believe, was in common use in 1876—I know it was in 1880. The arrangement of which Wilde's machine is a type was in common use in 1876.

Was what is now called compound winding known at all to scientific men in 1876?—I believe not.

Was there any arrangement known in 1876 whereby the electricity was divided on the principle of bifurcation?—Unless in so far as shunt was known and it constitutes a bifurcation.

Witness was directed to the passage on page 8, lines 38 to 50, of Varley's specification.

I ask whether, in your judgment, any electrical workman in 1876, reading that passage, would have had disclosed to him the system of series-shunt winding?—No, I think not.

Do you think that it would have been easy for an electrical workman at that date, reading the specification carefully, to have reached any conclusion as to what the patentee meant?—I think he would have been very much puzzled. I have been puzzled within the last month to understand it because of seeming inconsistencies in different parts of the statement.

The puzzle, I presume, would have been all the greater in 1876?—Yes, decidedly so.

And were the puzzles precisely such puzzles as would actually mislead the ordinary workman?—Yes.

Would you just mention some of the puzzles which you found it difficult to reconcile?—The first sentence says: "Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets." I don't think it is quite clear how the part was to be obtained. The workman of the time would consider how he was to get a part of the electricity and divert it from the external work of the machine to sustain the power of the magnets. I find "the remaining portion is used to produce the electric light." If that is divided into two parts in some way, this would be clear enough, provided the remaining portion is used simply to produce to the electric light; but the reader is led off the idea that the remaining portion contributes in any way to the magnets. The reader will understand it is used to produce only the electric light. Then he goes on: "There are several well-known ways of doing this, but the method I prefer is to wrap the soft iron magnets with two insulated wires, one having a larger resistance than the other." This is not the way of doing that which is specified in the first sentence, and so the reader becomes bewildered. A new idea seems introduced here inconsistent with the first sentence. He goes on to say: "The circuit of larger resistance is always closed, and the circuit of less resistance is used for the electric light." These words certainly would imply to a reader then—and I think to a reader now, taking these words and not thinking of compound winding, which he knows from subsequent use—two circuits, one circuit of larger resistance which is always closed, and another distinct circuit of less resistance, which is used for the electric light.

When you speak of two complete circuits, you mean having separate sources?—Separate circuits having separate sources.

If the workman aimed at reconciling the difficulty he would, in your opinion, probably betake himself to the separate circuit arrangement as being the least inconsistent with the whole passage?—The passage is not sufficiently clear to give directions to the workman. Witness went on to state how a knowledge of Wlide's machine might help to explain the difficulty.

You do not suggest that Wilde's machine would perfectly reconcile all the inconsistencies?—It would give an idea to help the workman to carry out the instructions.

Suppose the workman were not to stop short at this point, and put the specification aside as a conundrum, but were to go back to the patentee's previous patent, or to the previous part of the specification itself, would he, in your opinion, derive any further light, or would he be additionally puzzled?—I think he would be still somewhat puzzled, but I think he would see his way to carrying out the instructions as to the groups and commutators which are given in different parts of this patent. There is one point, however, that would be a considerable difficulty to him, that is, how to reconcile the statement that there may be an odd number of groups with the statement: "The alternations of north and south poles, between which the bobbins revolve, correspond to the number of groups." That reading is quite inconsistent with the meaning of their being an odd number of groups, because the number of pairs of poles must be even.

What does the odd number of groups suggest as to the use to be made of any odd group?—It implies that each one of the whole number of groups must be coupled up in itself independently of the other groups.

Are there various other passages in Varley's specification which appear to you to be misleading or absurd, as I believe they might be called, only I do not wish to use strong language?

His LORDSHIP remarked that it was somewhat late in the day for the Dean to modify his language.

WITNESS: I don't like to use that word with reference to any statement of electrical theory, because language varies so much. What is absurd in 1888 was not a bit absurd in 1876.

Taking what is now known and recognised, what do you say to this passage: "The capability of the machine just described, and of others of its class heretofore constructed, is limited to a considerable extent, because the force consumed in giving force to the machine is being converted into magnetism and electricity at the same time"?—Witness was understood to say that he had no idea what was meant.

WITNESS afterwards read and commented on other passages of the specification which he considered inconsistent and misleading, and ended by saying that if the directions were followed the machine constructed would be a bad machine, and if the special arrangement of commutators were introduced the machine would not work.

It has been suggested that the passage on page 8, lines 19 to 21, taken in connection with the passage at line 38 on the same page, sufficiently discloses a series-shunt winding. What do you say to that?—I cannot see it in that light at all; I do not think it does.

If you turn to figure 17, where you find a drawing of section arrangements of commutators, do you find that a double winding is used?—There is no double winding printed here.

How is the electricity which is assumed to operate this particular arrangement on page 8 supposed to be got; by what system?—By the bobbins as described; the groups, if I remember aright, of three each.

Working on what system?—Making a plain series machine. That is quite clear.

And I think in the passage, at line 38, the patentee does not confine himself to his new double winding arrangement, but merely gives the preference to that over other well-known ways?—He speaks of several well-known ways, and intimates his preference for one of them, as I understand it. The word preference does not tie him to the new way.

You do not find in the passage on page 8, line 19, or in any of the relative drawings anything inconsistent with separate excitation from an internal source having been the principle of Varley's new arrangement?—No.

If you turn to page 7 and look at lines 15 to 19, do you find provision made which points to separate excitation within the machine?—I find the provision of as many commutators as there are bobbins. These commutators must necessarily then correspond to the groups of bobbins. If there were three bobbins in a group there will be a triple commutator for each group.

Is the result of what is there proposed this, that you have arrangements made for the separate excitation within the machine?—Yes; quite so.

Is it your view that if the workman went through the specification and overcame its inconsistencies, what he would reach was excitation from a separate source within the machine and not series shunt winding?—I think the most direct way that would occur to him of realising it would be separate excitation, but I think it quite possible even in 1876 he might have been led to the series shunt by the description.

Asked to examine Varley's machine, Sir William said:—I am familiar with experimental machines. Varley's machine certainly appears to be an experimental one from the unusual number of terminals and loose wires. I suppose the machine might be used in a variety of ways. The brushes are not in the machine. I do not think it possible, taking the machine as it stands, to say how it was used. It would be quite in accordance with the usual practice with experimental machines to keep the couplings loose. If it were a machine used in work I would expect no loose wires.

Now I will come to commutators. Have you studied the provisional specification—Haddan's?—Yes.

And the descriptions in the final specification?—Yes. I have also studied the claims.

Will you tell me whether in your view the claims in the final specification go at all beyond a fair carrying out of the invention disclosed in the provisional specification?—I should say that there was only a legitimate working out of that which is foreshadowed in the provisional specification.

The whole of the claims, do they not, tend to increase the cylindricity of the machine?—They give means of practically keeping it true and of renovating it when it is worn out too much.

Take claim 6; is that a claim or a combination under which the number of gaps upon the surface of the machine would be considerably diminished?—Yes, by putting in bearing pieces to prevent the brush falling into a gap and mischief of various kinds.

Have you been shown the Wilde commutator?—Yes.

How does it strike you as compared with Brush's?—I think the mode of fixing on the segments that experience the wear is different from Brush's. In this case the wearing segment, No. 27, is attached by screws from the inside, in order to keep it off the commutator. In No. 28, the wearing segment is fixed by screws from the outside, as Brush's is. But these screws have not the special form of Brush's screws, which allows the screw to wear down uniformly with a wearing segment, and yet not to lose its power of holding.

Does it strike you at all as an anticipation of the Brush commutator?—I have not had an opportunity of looking closely into it.

Cross-examined by Mr. GRAHAM MURRAY: You told us that shunt winding was not ordinarily known till about 1879?—Yes, 1879 or 1880.

You are aware, are you not, that Wheatstone had disclosed it in a communication to the Royal Society?—Yes, but not clearly. I could scarcely consider that to be an anticipation.

It is treated as a shunt arrangement, even by Siemens?—Yes; rather more credit, I think, was given to Wheatstone than possibly he deserved.

However, I am entitled to this, that when Siemens comes to work out adaptations of the principle, he treats as it appeared disclosed by Wheatstone?—Yes.

You know Clark's patent. There is no doubt about it?—No; that discloses it with great clearness.

Now as regards bifurcation. Bifurcation of an electric current, simply splitting or joining two wires into one, was, of course, very well known for a long time?—Yes, in telegraph wires.

I do not suppose you suggest for one moment that that was an idea beyond an electrical workman if he thought it necessary to bifurcate the current?—No.

Now I come next to the passages that you say are puzzling in Varley's patent, and the first, I think is, that you say it is not shown how the part of the electricity diverted to maintain the magnetism is obtained. I pass over that and come to the next, which says that "the remaining portion is used to produce the electric light." Now your reading of that is you read "simply" or "only"? You say that the natural meaning of the sentence would be more accurately given if the word "only" were added?—Yes.

Are you inclined to the reading of electricity there that it means electric energy rather than electric current?—I would not read that as meaning series.

But what do you read electricity as meaning; is it electric energy, or electric current?—I do not know; and I may say it would make no difference to me which name you give it. In construing this sentence, it would be the same thing which term was used.

If electricity meant electric energy it would be true to say of a shunt machine that part of the electricity developed is diverted, &c.?—Yes, that would be the meaning.

Now let us take it as meaning electric current. You quite candidly say that you read the second portion as being the remaining portion which is used only to produce the electric light. Now, it is true, is it not, that the language is consistent with what occurs in the series machine?—It is not absolutely contradictory, but the first sentence is very misleading.

It is true of a series machine, is it not, to say that a portion of the electric current which is not used in the shunt does maintain the electric light?—Yes, but it also does something else.

Well, now look at lines 43, 45 and 46 of Varley's specification, which states "when the electric light is being produced the greater portion of electricity passes through the circuit of less resistance, which I term the electric light circuit, maintaining the magnetism of the magnets and producing the electric light." Does that not just give you the additional function which it was to perform?—That implies that the current through which the electric light is maintained does pass round the magnets.

And, therefore, that is consistent, and, indeed, indicative of the series portion of a series-shunt machine?—Quite so.

Now, going back to lines 38 and 40, there are just two portions dealt with, first, the part which is diverted, and secondly, the remaining portion, which is used to produce the electric light. These two are exhaustive of the whole?—Yes.

The first is consistent only with either shunt or separate excitation?—I think it must be held to mean either the one or the other.

You could not suggest anything else?—No.

Now does that not lead you to this, that a machine as described in the first sentence must be a machine which has excitation of the magnets by the series arrangement and has also excitation of the magnets either by a shunt arrangement or by separate excitation from the armature?—Either by shunt or in a separate circuit.

Now, your next point against this description of the series shunt was when he speaks of two circuits, and you think that that rather does not indicate a bifurcated circuit?—No. I think the words imply two circuits.

Now, if you notice Brush quite clearly describes the series shunt arrangement and uses precisely the same terms?—I think it very likely, because "circuit" is continually being used for "branch."

His LORDSHIP: Then it might have been used by Varley in the same ambiguous way?—It might.

Mr. GRAHAM MURRAY: Now I have got this that the machine as described here must be a machine which has a series connection, but may either be one of excitation or may be series shunt?—Yes.

Now I understand first of all that you point to a passage on page 7, line 15, dealing with the number of bobbins in each group. Now I think you admitted that it would be mere absurdity to think that when he uses the words "correspond in number to an uneven number of bobbins," he means exactly the same number as the magnets. Given an even number of magnets, or fields as you put it, of course the number of bobbins may be either even or uneven in number?—Yes.

Now you say that Varley at line 15 says that the number of bobbins may be 2, 3, or 4, and that the number of commutators may correspond to the number of bobbins forming a group, or be increased in number?—Yes.

Now that shows that you may either have one commutator for each group of bobbins, or one for each bobbin?—Varley calls three commutators the triple commutator for one group. There must be for each group a compound commutator with as many plates as there are bobbins in the group.

It follows that you may have either a machine arranged with a commutator correspondingly to the number of bobbins, or with a commutator for each bobbin?—Yes.

The different electrical effect of these two arrangements is this, is it not, that in the first, the bobbins are arranged in parallel, and in the second, in series?—They may be arranged either in series or in parallel in the circuit.

Is the result of this that when you have the bobbins in parallel you have more current and less potential and when you have them series, less current and more potential?—Yes.

With a machine where the commutators were all connected in series, is not the idea of separate excitation necessarily excluded?—Not necessarily, because one group might be kept out of the series. If they are all in series separate exitation is excluded.

The hypothesis which I have put is a hypothesis which does describe a machine which, according to Varley's method of construction, would get the very highest potential which he could obtain?—Yes.

And it is a different machine from one of the types which is described at line 3 of page 8 and the following lines?—Yes.

Now, there were a few passages that my learned friend called your attention to next where Mr. Varley says something about storing magnetic force, and I think you said you did not like to call that absurd. Would you like to say that words used by you now would necessarily be quite correct according to scientific knowledge in 1898?—I hope not.

Well, that matter of the storing of magnetism, if wrong, would not make any difference upon the working of the machine?—The one which the claim is founded upon must be admitted to be erroneous.

Well, the actual machine for carrying out the method. The machine where you cut out one of the armature bobbins at a certain part of the revolution. That is not a bad thing?—Oh, it is a very good thing; but there remains a throwing in of the bobbins sooner than it ought to be, that being done because of a false theory.

In fact, you think that Varley's actual apparatus for cutting out the armature bobbin at a certain part is not as complete as Brush's was afterwards?—I think probably it would be found to be not so well proportioned as it would have been if the principle had been correct.

Now, does it not come to this: that while it acts satisfactorily so far it would have acted more satisfactorily if it had been cut out for a bit longer?—I think so.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

THE Seventeenth Annual General Meeting of this Society was held at the Institution of Civil Engineers on the 13th instant, Mr. Edward Graves, President, in the chair.

The PRESIDENT referred to the death of M. Gaulard in feeling terms, and said that it was most untimely and unfortunate, as M. Gaulard had passed away while yet a young man, and when just upon the realisation of his hopes in regard to working with transformers, of which he had been the introducer.

The SECRETARY read the Report of the Council, which stated that the number of new members elected into the society during the year exceeded the average, and included 19 foreign members, 9 members, 104 associates, and 36 students; and 35 candidates would be balloted for at the next meeting. The number of deaths had been considerable—5 foreign members, 7 members, and 8 associates having passed away; while 4 foreign members, 9 members and 14 associates had retired.

The council had awarded the following premiums: the society's premium of £10 to Professor S. P. Thompson for his paper on the "Influence machine from 1788 to 1888;" the Paris Electrical Exhibition premium, value £5, to Mr. A. C. Cockburn for his paper on "Safety fuses;" the Fahie premium, value £5, to Mr. E. Stallibrass for his paper on "Deep sea sounding in connection with submarine telegraphy." A new rule had been decided upon which gave the chairman of a meeting power to ring a bell at the end of ten minutes when a speaker addressed the meeting so long in discussion, and that if in two minutes afterwards his remarks were not closed the question of his being allowed to continue should be put.

The Nomenclature Committee had prepared a draft report, but its final approval had not yet been accomplished.

The committee appointed to revise the rules issued by the society in 1883 for the prevention of risk of fire arising from electric lighting hoped to have been instrumental in bringing about a general adoption by all fire insurance offices of one set of rules, to be modified from time to time, as occasion required, by which inconvenience to the offices, electrical engineers, and contractors would be avoided. The fire offices generally supported the committee, but the action of one fire office compelled the society to limit their consideration to the general rules of 1883, leaving the fire offices to issue their own rules as they thought fit. The Government having decided to take no official part in the Paris Exhibition of 1889 M. Berger had suggested that the society should communicate with the representatives of electrical industries in this country to ascertain if they would exhibit. The council consented, and the necessary steps were taken, but the result was not sufficiently satisfactory to encourage the council as a body to act in the matter. Several members of the council had, however, been nominated on the Mansion House Committee, and they would look after the interests of exhibitors generally. The financial position of the society continued sound, but the expenses had largely increased owing to the holding of several extra meetings and the more frequent issue of the Journal.

The students' meetings had been very successful, and not only had the principal papers read before the society been discussed but the students themselves had also provided several papers. Steps were being taken to introduce the new title of the society, which, on the 1st January next, would be called "The Institution of Electrical Engineers." The report was adopted, and votes of thanks were passed to the Institution of Civil Engineers for the loan of their rooms for the meetings of the society, and also to the various officers of the society.

The adjourned discussion on Mr. H. Edmunds's paper "On a system of electrical distribution" was resumed.

Mr. MORDEY: The meter which Mr. Edmunds proposes to use appears from the description simply to add up the number of charges received by the cells in a given time. This counter did not, so far as he understood the author, take any note of any loss that might occur on the line or in the cells, and in the event of the people at the station supplying say 50 or 60 ampères instead of 70, it appeared that the meter still charged the customers for 70 ampères. What safeguard had the consumer that the meter really measured anything? No doubt some check was provided.

Mr. H. EDMUNDS, in reply, said: Since reading my paper on "Electrical Distribution," I have carefully considered the discussion thereon, and also noted the various comments in the journals and other quarters on the subject. It has occurred to me that I did not give sufficient data or details in order to make the system fully understood in all its bearings. I think that Mr. Mordey's question is one among others that will show that, and I may at once reply to that question and say that the arrangement we use is a solenoid through which the current passes when it comes from the charging main into the batteries. This solenoid is so wired that if anything under a 70 ampere current comes in it does not respond; the consequence is that if the central station sends out 60 amperes they do not have any record at all; if they send out more than 70 amperes it is their loss; and if they send out exactly 70 amperes then we get the number of revolutions, which are a fixed quantity. We know the time recorded for each distributor, we know the potential required in each distributor, and we know that the 70 ampere current gives the watts, we take the time by counting the revolutions in the shunt; and in that way we get what goes into the cell. Mr. Mordey very properly put it that it is hardly fair to charge what goes into the cell, but to charge for what comes out. I think that that can be got over by charging a fairly low rate per unit, and it has been suggested to charge the consumers 6d. per unit; by that means I think we can very fairly satisfy them on that point. I claim for the system something more than a mere set of complicated mechanical devices for attaining certain ends which might be attained by much simpler means, or might be shown to be unnecessary; therefore, if you will allow me, I will not merely reply to the several questions raised, but will add something to my previous remarks, in order to make you more intimately acquainted with the subject, for one is sometimes apt to think it superfluous to inform our audience about small details, and points which really are necessary to be recognised, in order to understand the subject as a whole. If, therefore, in this reply I should either repeat myself, or give you obvious or well-known information, I must beg you to excuse this on the grounds that I wish to be fully understood. I have decided to reply to the several speakers as a whole rather than in detail, and have analysed and arranged the various points raised in the discussion and comments accordingly. First let me express my thanks for the recognition accorded by the members to the ingenuity of the scheme, for such recognition is most encouraging, and is one of the most valuable recompenses one can obtain. I also appreciate the various suggestions made as to the desirability of simplifying the details and removing unnecessary parts. It was said that the machine was "fearfully and wonderfully made," that the generator might be all right, but that the means for carrying out the details were very questionable. I am pleased to say that, since I was here, I have simplified the apparatus, so that, instead of measuring 18 inches by 9 inches it only measures 12 inches by 7½ inches over all. Instead of 32 contacts there are only 8; and instead of costing £25 to make they ought to be produced at less than half that sum. In fact we have really stepped into the thing in such a way that now, instead of it being a scientific toy, I hope it will be a practical working instrument. What is still more important, the new instrument, being free from all springs and cams, it can never, under any circumstances, open the circuit and cause the lights to go out. This, I think, deals with Mr. Preece's and Mr. Reckenzaun's objections as to the apparatus being too complicated. The absence of sparking also enables me to depend on the several contacts working freely, the reason for non-sparking, and non-fluctuation, being that we never break or open the circuit, for all the changes are made, either by giving an alternative path to the current through the cells, or through a suitable resistance. There is also an absence of fumes to tarnish the working parts. Mr. Reckenzaun remarked that he thought the fumes of the gases evolved from the cells being charged were rather hurtful to an arrangement of that kind. The cells evolve gas but slightly, and the bubbles, when liberated, are trapped by a cover of solid paraffin, which prevents evaporation, and the escape of acid spherules. The hydrogen gas evolved charges the the solid paraffin cover in bubbles, and there condenses, and

what hydrogen comes off is practically harmless, and does not seem to affect the instruments working in the vicinity of the batteries. It is also interesting to note that although we are charging with 70 amperes, carrying on the charge for 24 hours, and bringing up the batteries to a high point of charge, that we have not any amount of gas liberated. Now comes the question as to the necessary charging potential. I said in my paper that we could charge cells intermittently to their full charge, with a mean voltage per cell of 2·25 instead of a constant 2·5 per cell, as is required where cells are charged continuously; and I wish to explain this, and to show why this differs from ordinary practice alluded to by Mr. Reckenzaun. In the first place I said a mean or average voltage, and not a constant potential. We have a constant current of 70 amperes, and that is our only constant; the charging potential varies with the change in counter E.M.F. in the cells, due, as Mr. Reckenzaun points out, to the hydrogen gas in a nearly fully charged cell on the negative plate giving a fictitious E.M.F. But these are the very points of difference between ordinary practice, such as Mr. Reckenzaun refers to, and the system employed here. Let us try and disabuse our minds about a fully charged cell, as ordinarily understood, which, by the diagram, would mean a condition where, after many hours continuous, not intermittent, charging, we get, in a set of cells, a counter E.M.F. indicated, while being charged, of, say, 2·5 or more (this being the point when it is usual to consider a cell as fully charged), and when we cease charging. If we refer to the diagram I can explain what I mean. I believe that the practice generally is to commence charging a cell, and to continue charging for a given number of hours. We will say that we are charging, as shown, with a 60 ampere current, you charge for one hour when you find that a rise has taken place in the potential at the terminals of the cell from about 2 volts to 2·15 volts. As you go on charging it continues practically constant up to 2·2 volts, that is when a 5 hours' charge, or 300 ampere hours, has been put in. Now, since I read my paper, I have tried an experiment of this nature: I took cells and charged them intermittently and found that by giving a cell a 2-minutes' charge, I took the potential with a voltmeter before placing the cell in the charging circuit, and found it to be about 2 volts—of a 70 ampere current, which was indicated and was quite constant, there was an immediate rise from 2 volts to 2·1 volts, but that in another two minutes I only got from 2·1 to about 2·2, or two-tenths. I am speaking now of a cell that had perhaps about 300 amperes in it at the time. If I continued the charge beyond 2 minutes then I found that the cells had a tendency to gas, and at that point the fictitious E.M.F. that Mr. Reckenzaun alluded to comes in. But if we discontinued charging at the end of 2 minutes, then we got 70 amperes with a charging potential of 2·2 volts; the cell is then put in the cycle, as shown in the diagram, fig. 4, into parallel with a cell which is receiving its charge. The cell is removed from the charging main, resistance is put in as explained at the last meeting, and the voltage at the moment of leaving is about 2·1. When one cell of 2·1 is placed in parallel with another of 2 volts there is a tendency for the two to equalise one another, but it is only momentary for the fresh cell comes in and can receive its 70 ampere charge for two minutes without having raised its potential more than 2·2, and I find that I can bring the 70 amperes into my cells as a whole in 24 hours in the way which we desire and yet never have had a charging potential higher than 2·25 volts in order to do it. That, I think, will probably answer Mr. Reckenzaun's question. Now, I would ask another question, and that is this: Why do we cease charging? What is understood by a full or an empty cell? for, under some circumstances, it would answer our purpose to continue charging many more hours, if we were sure we could economically do so. That is, if we could get back again the 98 per cent. of the energy put in which Mr. Preece told us about. We cease charging, because the energy put into, or rather expended on a cell after a certain period, is not returned to us as current, but is practically wasted in overcoming the fictitious counter E.M.F. and in doing work, in decomposing water, and producing heat without useful effect. Now, note the difference in practice. We only charge a cell whose E.M.F. is, say, two volts for two minutes. What happens then? There has not been time for the hydrogen to appear and develop the fictieious E.M.F. Mr. Reckenzaun refers to before the cell is removed from the charging circuit, isolated, and then placed in parallel momentarily with another cell, into which it would then discharge were there any difference of potential, and then it takes its place in the local group, either resting or discharging, according to the then requirements of the local circuit. The same conditions apply to each group of cells in turn, and that is why I maintain we can charge cells with a constant 70 ampère current and a mean potential of 2·25 volts per cell. But now comes the question, to what point do we charge them? How much energy can we get into them, and how much can we get back again? What are the dimensions of the charging station plant, and what does it cost to operate this system? At the last meeting several members wished to know this, and since then I have been much questioned about these matters, and also why we are justified in adopting a system with complex details in lieu of proceeding on more simple lines. I will try and explain. With regard to the charge in the cells, Mr. Bate remarked: "It seems that not only will the system of secondary battery distribution not reduce the cost, but that it is liable to increase it, not only over transformers, but also over other battery systems. Here, if the batteries are discharged at more than an average rate of one-third of the charging current, we shall not only have no accumulation, but we shall have a loss; and, therefore, taking 70 ampères as being put in, the battery must not discharge at more than 20 odd ampères. The cells would therefore be very much larger than if, as is done in the Colchester system, the batteries were allowed to discharge at their full rate, and then replaced by others of equal capacity, by which means it would seem that we could get twelve hours charge and discharge. Mr. Preece, however, says we can get 98 per cent. efficiency at a low discharge, whereas here we could get only six hours charge out of twenty-four." If Mr. Bate's conclusions were correct, I certainly should not feel justified in taking up your time in bringing such a system to your notice; and here, again, I feel that fuller explanation is necessary, and I will therefore take an example of what we would do in actual practice. Suppose we determined on only having 2,000 volts potential at our station, and a 70-ampère current. This would represent 140,000 watts. We can use for this at our central station, say, six dynamos, each giving 400 volts by 70 ampères, and each driven by a 50 H.P. engine. This would provide an ample margin of power, allowing us to use a ten mile circuit in addition to the batteries. This circuit would demand an additional 300 volts, if we had a circuit of $\frac{3}{20}$ths, such as we are now using, bringing the total voltage up to 2,300 volts. In addition to this plant, we would have two spare engines and two spare dynamos; making, in all, eight dynamos and eight engines. We would also provide four boilers, of which three would at any time be more than sufficient for the work required, leaving one over, with its engines and dynamos, as a reserve. Now, let us consider what we can do with such an amount of plant in the central station, and see how many batteries we can charge on circuit. This will give us some indications of the value of the system on a large scale. We can divide our 3,600 cells so that they can supply 112 centres. Each centre would be capable of supplying current locally of 48 volts by 70 ampères for eight hours, provided the station were run for 24 hours. This would practically enable us to maintain at each of those centres 70 16-C.P. lamps, or a total of 7,840—say 8,000—16 C.P. lamps on an extended circuit of 10 miles at 112 centres. Now, what would such a plant cost, and what would be the running expenses? Also, what would be the scale of profit. This, I think, is a most important feature for consideration in such a paper as this, and I am glad to say I am prepared with figures from actual experience on this point. From first-class contractors I learn that we can have our eight dynamo, eight 50 H.P. engines, four 100 H.P. boilers, stack building, instruments, and ten miles of circuit with the fitting, wiring, and sundries included in the station, and on the circuit, for £12,000. In addition to this, our 3,600 batteries, at £6 a-piece, would come to the large item of £21,600. Our 112 distributors at, say, £10 each, £1,120. The erection of batteries would cost, say, another £1,000, but the consumers would, in most cases, be asked to supply a room, and at any rate pay for the fitting up of the batteries, so that these need not be charged wholly to the supply company. This would give us a grand total of £35,720. Now let let us see what it would cost to run this station at 24 hours a-day for 365 days in the year. Let us suppose that we have the six engines, six dynamos and 3 boilers, and run these continually day and night, so that, practically, we shall have the maximum that this plant would cost, because this would certainly be the outside cost that that amount of plant would represent. We will allow 4 lbs. of coal per H.P., which, at 240 H.P. for 24 hours a-day, 20s. a ton, gives us a total of £3,756 for fuel. We will take oil and waste at 6s. 6d. per night, giving us £119. Water at 1s. per 1,000 gallons, giving us a total of £300. We will allow wages, £1,565. We will take rent and taxes at, say, £500. This gives us an annual expenditure of £6,240. Now, we will say that we get a revenue of 6d. per unit of the current passing into the batteries, which, by the system of metering proposed, we could ask. This would give us, on the output of such a station, a gross revenue of £84 per day, or £30,660 per annum. But such a revenue would only be obtained if the total amount of energy in this station were consumed eight hours per day throughout the year. Therefore I have made a calculation as to the revenue accruing from a less consumption than this. We will take, for example, an average of one hour per day, £3,832 10s. per annum; two hours per day, £7,665 per annum; three hours per day, £11,497 10s. per annum; four hours per day, £15,330 per annum; and this latter is probably about the average throughout the year that we could depend upon. This would only necessitate the station working upon an average 12 hours a-day, instead of 24 for which we have reckoned, in which case we should cut down our fuel charge one-half, reducing that to £2,000, and our wages we might reduce by one-third, leaving £1,000, the rent remaining the same would give us a gross cost of £3,500 per annum, with a gross revenue of £15,330, leaving £12,000 to the good. This, however, would be by no means all profit, as we must now allow for depreciation of the machinery and batteries. It is usual to write off 10 per cent. for machinery, which, for our engines, dynamos and boilers would be £600. The depreciation of the batteries is more of an unknown quantity. My own idea is that 10 per cent. per annum ought to cover these, but we will put it at 15 per cent. £3,240, which is a liberal depreciation. This would leave us, therefore, a gross profit of £7,990 on the supply of current for an average of four hours per day. Placing the capital at £40,000, this would give us a profit of 20 per cent. This, I think, is the most attractive feature in the system. Of course it is often said that figures can be made to prove anything, but I think I have dealt very liberally with all the cost of the plant and the depreciation; and, should we increase the demand from an average of four hours per day, you will understand that the profits mount up very rapidly.

This, I think, is the best reply to make to the questions raised by Mr. Bate, and to similar remarks made by others. Mr. Bate and Mr. Preece thought that the proposition to run an engine without a governor was a novel one, but I can assure them that there is no difficulty in achieving this in practice. Nor do we pay too heavily in our coal bill, for I find that in our high-speed engines actually in use, instead of the coal being 4 lbs. per H.P. it is about 3 lbs. to evaporate 30 lbs. of water. We get over the difficulty of slow speed by running a suitable number of small engines, and the E.M.F. required to charge the 10-mile line we contemplate here being about 300 volts we could always ensure our engines, as we arrange them, running at least at 150 revolutions a minute. We have not found, in practice, that any difficulties have occurred in this direction. A question was raised by Prof. Forbes about lamps having 2½ watts efficiency. I remarked about 2½ watts, and did not state it to be actually that. I find on investigation that with an actual 2½ watts they blacken too soon, and though the filaments last 1,000 hours, the lamps are not so useful, owing to the blackening and higher resistance for more than 400 or 500 hours; but at about 2·7 or 2·75, with a perfectly constant potential, so that we do not overstep the mark, even for a short time, we can safely rely on the lamps coming up to their 1,000 hours. I find that a very slight difference in temperature, when working at this high potential, is enough to cause all the difference between length or shortness of life in the lamp, and therefore with such a system as the one contemplated, it is important to know that we can depend on a certain potential which is practically constant at all times. Several allusions were made as to the undesirability of introducing motor generators into this system. I do not think that they are essential, but I think they form very valuable auxiliaries, and I think it is well to look to the absorption of more current from the charging station, by means of motor generators and electro-motors, than would be taken by the demand on the batteries, in order to increase our revenues. Further, the cost of batteries is the most heavy one in this system, and although we have enormous advantages when they are going to be used to their full capacity, yet, should we have to meet a large demand for a very short time, it would probably be better to have a small number of batteries with the auxiliary of a motor generator, than to have the larger number, with their interest and depreciation going on, and which interest and depreciation could not be equal to the revenue accruing from them. That is why I deemed it desirable to have an auxiliary of this kind, but it is only an auxiliary, and not a necessary part of the system.

The important features of my system are the reduction and simplification of the plant in the charging station, not necessitating that the engines should be running all the time at an absolutely constant speed, and requiring the particular attention such conditions demand. The reduction of the potential at the charging station to a point not exceeding 2,000, which, as we have seen, is sufficient with a 70-ampère current to supply an 8 hours' demand of 8,000 16-C.P. lamps on a 10-mile circuit, or by increasing the batteries and running on a double line (or in the alternative method I spoke of last week, where the charging station to supply four hours' discharge, which is the amount we have based our revenue upon), would allow of double the amount of work in a 24 hours' run at the station, thus giving 16,000 lamps. All these points are very desirable in the interests of economy and safety. The absence, also, of any high potential in the local lines of the system is a feature of great importance, getting over the vexed question Mr. Preece referred to of highly-insulated wire. The assurance that, even should there be an accident at the station or an interruption of the line, there is always a reserve throughout the entire system: the bringing of the local batteries near to their work considerably reducing the cost of the mains, all point to the commercial as well as the electrical and mechanical advantages of this system. I think that what I have said has covered the several questions that were asked; but if not, I should be glad to answer any further remarks.

The PRESIDENT proposed a vote of thanks to Mr. Edmunds for his paper, and the motion was heartily carried.

Scrutineers of the ballot papers having been appointed,

Mr. W. H. PREECE, on the invitation of the President, made the following remarks upon the method adopted for the election of members of Council: As you are all aware, I am one of the original members of this Society, and for many years have spent some of the pleasantest evenings within my memory in taking a most active part in its proceedings. During the existence of the Society many changes have been carried out, their adoption not always being carried by the unanimous vote, or sometimes the vote of a very large majority of the Council, but most of them have certainly been for the good of the Society. But one change that has been made I want to call your particular attention to, for I think I shall show you, as I certainly feel, that it has been detrimental to the interests of the Society, and it is a matter that affects the Council itself. In bringing this point forward it will be clear that I can have no personal interest to serve, for I have passed through all the honours that the Society can confer, and my action is therefore rather in the interest of those who may form future Councils than those at present acting on or who have passed through it. At one time it was our custom to submit a full and complete list of those who should constitute the Council to the vote of the Society. The Council, in looking after the conduct and interests of the Society year after year, selected a list of those members who should be submitted for election. That practice continued very well, and was followed by most of the principal Societies, with the exception of our parent Society, the Institution of Civil Engineers, whose practice has been to submit to the members of the Corporation a long house list, containing not only the names of the existing Council, but also those of many eminent men from whom the members could elect their representative body. Our own Society and that of the Mechanical Engineers did the same. At one of our annual meetings it was suggested that the members themselves had not sufficient voice in the election of members of Council, and it was decided to submit to the Society a list containing more names than there were Council seats for. I am sorry to say that that has worked very badly indeed. Men of eminence will not submit to a process of competition, and they decline to be placed on the list with men of equal eminence to themselves, and year after year refusals have been received from men whom the members would be glad to see on the Council. Others who have agreed to appear on the selected list and have not been elected have lost all interest in the Society, and have not come amongst us again. Our Society is rapidly increasing in numbers, its members belong to various sections and fields in which electricity is applied, and it is evident that if the Council is to properly represent the Society it should fairly represent each section. Recent correspondence has appeared in the technical journals, and "A Telegrapher" has pointed out that, as regards telegraphy, the origin of the society, the workers in which are scattered all over the earth, and the majority of whom are away from England, cannot attend the meetings to record their votes, is not adequately represented. Telegraphy is a very important branch of applied electricity, and two men who held extremely high positions in it, whom the society would have been glad to receive as members of council, declined to submit their names to competition. There are many reasons which I could give in furtherance of the proposition I am about to make, but the principal one which I would urge for reverting to our old practice is, that not only is our present practice exceptional, in company with only two others, but I can mention that one of the others, the Institution of Civil Engineers, has under its consideration, and it was brought very prominently before its council last year, the motion I am now about to propose—"That in future the council revert to the old practice of submitting for election a complete list of the council."

Prof. FORBES seconded the proposition.

A discussion followed, and after several members had spoken in support of the motion, while others objected to any hasty decision on the point, Mr. PREECE modified his original proposition, and moved—"That the council issue a circular to the members of the society, asking them for their opinion on this question," the circular to merely state the facts set forth on either side. This was seconded by Mr. W. T. GLOVER and supported by Prof. G. FORBES, and carried.

The result of the ballot for the new council was as follows:—*President*—Sir William Thomson, F.R.S. *Vice-Presidents*—J. Hopkinson, F.R.S.; William Crookes, F.R.S.: Prof. W. E. Ayrton, F.R.S.; Alexander Siemens. *Members of Council remaining in office*—Capt. P. Cardew, R.E.; R. E. Crompton; Prof. J. A. Fleming, M.A; Prof. G. Forbes, F.R.S.; Sir Douglas Galton, K.C.B.; Gisbert Kapp, Prof. J. Perry, F.R.S.; Sir David Salomons; Augustus Stroh. *New Members of Council*—W. Lant Carpenter; Sir. J. N. Douglass; Prof. S. P. Thompson. *Associate Members of Council*—Sydney Evershed, G. C. Fricker, Capt. A. E. Wrottesley, R.E. *Hon. Treasurer*—Edward Graves. *Hon. Auditors*—J. W. Blundell, F. C. Danvers. *Hon. Solicitors*—Wilson, Bristows and Carpmael.

A ballot for new members took place, and the meeting then adjourned.

Physical Society, December 8th, 1888.

Prof. REINOLD, F.R.S., President, in the Chair.

Dr. A. Gamgee, F.R S., and Mr. A. P. Trotter, B.A., were elected members.

The following communications were read: "Note on a Modification of the Ordinary Method of Determining Electro-magnetic Capacity," by Mr. J. W. W. WAGHORNE, D.Sc. In determining capacity absolutely from the throw of a galvanometer, and a steady deflection through a known resistance produced by the same battery, error may arise from the imperfect elasticity of the fibre (when short), and the resistances required are often greater than can be conveniently obtained. The latter difficulty may be overcome by taking a known fraction of the potential difference used for charging the condenser to produce the steady deflection, and the former error may be reduced by observing the first swing due to the permanent current, instead of the steady deflection produced by that current. By adopting this latter device, the logarithmic decrement need not be determined and the time required to make a measurement is considerably reduced. The formula for capacity (C) becomes $C = \frac{t}{\pi} \frac{d_1}{G} \frac{b}{d_2 a}$ where t = periodic time in seconds, G = resistance of galvanometer circuit, d_1 and d_2 the throws due to the condenser charge and the permanent current respectively, and a and b the resistances in the battery circuit from the ends of which the potential differences used to produce d_1 and d_2 are taken.

The above expression is not strictly accurate, because the damping effects on open and closed circuit are not identical, but in the cases observed by the author where the damping is not serious, the difference is negligible. A modified form of Pohl's rocking key was shown, whereby the two throws d_1 and d_2 could

be rapidly observed, and readings could be taken in opposite direction to eliminate error due to torsion of the fibre.

Dr. THOMPSON pointed out that error frequently arises from the capacity of the key being appreciable where small condensers are being used, but the author stated that the modification was not intended for such cases.

Prof. AYRTON remembered having used in conjunction with Prof. Perry, the throw due to the permanent current instead of the steady deflection, when experimenting with condensers certain E.M.Fs., and believed they abandoned it on account of the difference in decrement on closed and open circuits.

Mr. SUMPNER regarded galvanometers with small differences in damping, on closed and open circuits, as unsuitable for ballistic purposes, and mentioned a case in which the latter was only half the former.

Mr. BOYS considered the damping would be modified by having the condenser joined to the galvanometer terminals, and thought the decrement should be decidedly different from that on pure open circuit.

In thanking the author for his paper, the PRESIDENT said that any improved arrangements of well known experiments or of lecture apparatus, would always be gladly received; and reminded members in bringing such before the Society, they would be carrying out one of the chief objects for which it was founded.

"On Some Facts connected with the Systems of Scientific Units of Measurement," by Mr. T. W. BLAKESLEY, M.A. The author considers that the C.G.S. and practical (quadrant, volt, second) systems of units do not satisfy the requirements of a perfect system in which the chief ends to be kept in view are:—

1, *Correlation*; 2, *Simplicity*; 3, *Comprehensiveness*; 4, *Naturalness*; and 5, *Convenience*.

In a properly *Correlated system* all the quantities considered should be so connected by the equations representing the laws of nature, that no coefficients are required in expressing any unit in terms of others; for *Simplicity*, quantities essentially the same should be measured by the same unit; and to be *Comprehensive*, the system should embrace all the physical ideas which occur. To be *Natural*, its units should be closely or decimally connected with natural units; and for *Convenience*, they should agree with established (though arbitrary) units, either actually or decimally. In the two systems referred to, correlation has been more completely realised than any of the others, but simplicity is by no means satisfactory, and the want of comprehensiveness was discussed by Prof. Rücker at the last meeting. The "second" is unnatural in not being a decimal subdivision of the solar day, and the gramme is derived from the centimetre by assuming the density of water to be unity; whilst the inconvenience arising from the relation between the horse-power and the watt, or the erg, is universally acknowledged.

Two general formulæ are given for converting magnitudes expressed in practical, and C.G.S. and electro-magnetic measure, into C.G.S. electrostatic units. Let k and h be the dimensions as regards length and mass when the quantities are expressed in the E.M. system, and n and q the corresponding numbers when expressed in the E.S. system, then

1 practical unit $= 3^{n-k} \cdot 10^{10n-11q+k}$ electrostatic C.G.S. units, and

1 C.G.S. electromagnetic unit $= 3^{n-k} \cdot 10^{10(n-k)+11(h=q)}$ electrostatic C.G.S. units, the 3 arising from "v" being taken as 3×10^{10} cms. per second.

Though the formulæ may be found useful, the author thinks it would be far better to adopt one system for all measurements, and suggests a "coalition system," in which "v" is taken as the unit velocity. If in this system the "second" be retained, then the unit of length will be 30 earth quadrants, and if the quadrant be taken (as in the present practical system) as the unit of length, then the unit of time will be $\frac{1}{3\cdot0}$ sec. The influence of such changes on present standards is then discussed, and the relation between the new unit of power and the horse-power (H.P.) found to be unsatisfactory.

To endeavour to bring the H.P. and the unit of power into decimal relation, the author expresses the physical quantities in terms of length, time and power, from a table of which it is evident what units will be affected by changing the unit of power, and tables of converting factors are given when the latter unit is taken as ·746 watt or as 7·46 watts.

The correlation of temperature (θ) with other units is considered to be best effected by defining it so that $\jmath = 1$ in the equation $m\,l^2\,t^{-2} = \jmath\, m\, c\, \theta$, when "the units of temperature change would be that through which unit energy in the form of heat, would raise a unit of matter possessing unit specific heat," and by choosing air at constant pressure as the standard substance, $1°\,C. = 10^7$ C.G.S. (air) units. A summary is given towards the end of the paper, in which the union of the two electrical systems by choosing $\frac{1}{3\cdot0}$ second as the unit of time is recommended, the effect of which is to make the unit of capacity $\frac{1}{9\cdot0\cdot0}$ farad, and that of resistance 30 ohms. Before concluding, the author deprecates the practice of giving specific names to particular units, for by so doing, subsequent necessary changes are made much more difficult.

Prof. RUCKER expressed his opinion that temperature would be best correlated by expressing it as energy, instead of making its dimensions $l^2\,t^{-2}$ as suggested in the paper.

Dr. S. P. THOMPSON thanked the author for his prefix "*megisto*" denoting "multiply by 10^{12}." Referring to the choice of air as the standard for specific heat, he remarked that convenient coincidences were not always to be trusted, and that the specific heat of air depended on the pressure to which it was subjected.

CORRESPONDENCE.

Vulcanised v. Pure Rubber Insulation.

In a leaderette in your issue of the 7th inst., you quote some remarks made by Mr. Preece in the discussion on Mr. Edmunds's paper on "A System of Electrical Distribution," in which he asks for the reason why pure India-rubber insulation is being superseded by vulcanised India-rubber, and you yourselves express a desire to see his question answered.

With the hope therefore that it may throw some light on the subject, I propose laying before you one or two reasons which appear to me to account for this change.

1. In the method of application vulcanised rubber has the advantage, as the pure rubber insulated wires are, I believed without exception, covered by lapping rubber tapes on spirally, so that the coating of rubber is not a solid homogeneous one, but offers many opportunities for moisture to creep in. On the other hand, the vulcanised rubber is put on under pressure; and, after it has been cured, forms a solid and homogeneous covering, which enables this class of wire to be used without any fear of moisture destroying the insulation; a most important advantage, as damp is such a frequent cause of trouble.

2. With regard to the relative lasting properties of these insulators, I must beg to differ from the very decided opinion given by you. The best Para rubber, when in the raw state, will certainly last a very long time in good condition under certain circumstances; but it is a fact that this rubber is deteriorated by the processes which it undergoes in being made into sheets or strips suitable for covering wires; and that this rubber sheet or strip does not remain good, unless it is kept from exposure to light and heat.

The fact that the insulation of electric light wires always is exposed to a fair amount of heat is a most important one, for the continued application of even moderate heat helps very much the decomposition to which the uncured rubber is liable. Let facts speak for themselves. Some three years ago I fitted up a circuit, in part of which I used vulcanised rubber, and part pure rubber insulation. The two classes of wire were practically under the same conditions of current density, and after they had been in use for rather over two years, I had occasion to alter the position of some branches, so that I had an opportunity of examining the insulations. In those wires insulated with pure rubber, the rubber had begun to get tacky and soft, and it was most difficult to get the wires clean; whilst in those insulated with vulcanised rubber, the rubber was firm and in good condition, and came away clean from the wire.

On this point of durability, I would ask the question why, when it is found advisable to cure the rubber used for all other purposes, should an exception be made in the case of rubber used to insulate electric light wires.

3. Another point in favour of the vulcanised rubber is, that the specific resistance of the rubber is raised by the process of curing; that is, that the specific resistance of a piece of uncured rubber, whether pure or compound, is lower than that of the same piece after it has been cured in the presence of sulphur.

Now the fact which you quote about the samples of pure rubber insulated wire in your possession, may at first sight appear to contradict the statements made above; but, so far as the published information enables one to judge, these wires have been under exceptionally favourable conditions, as the rubber has not been exposed to light or to variations of temperature, being buried in the ground, and as they were taken up in 1881, presumably not used for the transmission of heavy currents. In this matter of temperature, therefore, they have been under totally different circumstances from most electric light wires; and this, it appears to me, accounts in all probability for the remarkable state of preservation of the rubber. But there is a further point to be considered:—Did the rubber efficiently insulate the wires whilst in the ground? It does not follow that this was so, notwithstanding the good con-

dition of the rubber, unless by some art (apparently lost to this generation) the pure rubber covering had been made homogeneous and waterproof.

In conclusion, unless I have already trespassed on your space too much, I would like to add a few remarks on the *experimentia docet* question which has been raised. I do not think that the experience of telegraph engineers has been by any means overlooked, especially where full details of the conditions and results arrived at are given; but it must be remembered that the conditions of working of a telegraph wire and an electric light wire are different, and that therefore it would not be safe to follow in all cases in the footsteps of the telegraph engineer. For instance, in a leaderette in your Journal, when speaking about the the discussion on Mr. Crompton's paper on the A.T. *v.* B.T. systems, you state that India-rubber has been tried and has failed under the conditions present in underground telegraph conductors; and it is well known that the Post Office use gutta-percha covered wires for this purpose, but is it on that account to be assumed that gutta-percha is better than rubber for electric light work?

Again, Mr. Preece says that, as the result of 30 years' experience, the Post Office always specifies pure India-rubber for aerial cables. It may be that, under these circumstances, it has answered its purpose, though if it is supported on insulators this does not necessarily prove that the insulation of the cable itself is good; and I should be surprised to hear that the rubber has remained fresh and good, if a current density at all equal to that employed in electric light wires has been used.

The fact that a wire which has answered for telegraphic purposes is not used for electric lighting, does not show that past experience has been neglected; but rather points to the fact that the difference in the conditions has been recognised, and that the electric light engineer has preferred to look out for something better suited to his requirements. In this he has had the benefit of the experience of India-rubber manufacturers, an experience which extends over more than 30 years, and is certainly, in a question of this kind, of at least equal importance to that of anybody else; and this experience decidedly points to the employment of vulcanised rubber, as it will be difficult to find any class of manufactured rubber goods where the rubber is not vulcanised.

Stuart A. Russell.

Electrical Engineering Symbols.

It certainly would be of great advantage to practical men if electricians could be persuaded to adopt a uniform code of symbols, for really it requires a great waste of "electrical energy" to take in and overcome all the "hieroglyphics" that one sees appearing in print from time to time as "electrical engineering symbols." The symbols proposed by Prof. Jamieson are, I consider, most practical. However, there are a few suggestions I propose to make, viz.:—If n (as in list) is used for number of turns, then clearly $a \times n$ would be ampère turns, and no second symbol is required. Again, in Kapp's formulæ I would suggest

$$K_L = \frac{a \times n}{R_m + R_{as} + R_a} = \text{Kapp lines} =$$

$$= \frac{\text{Ampères} \times \text{turns of wire on magnets}}{\text{magnetic res. (of magnets + air space + armature.)}}$$

Carrington Smythe.

December 12*th*, 1888.

I quite agree with the proposal made by Professor Jamieson, that electricians ought to agree to use one uniform set of symbols for all our more common electrical terms and quantities.

The importance of this has been very much impressed upon me by the fact that I have recently had to consult Thompson on "Dynamo-Electric Machinery," Kapp on "Electrical Transmission," and other authors. I have found the extreme diversity of symbols which denote the same thing to be (to put it mildly) most perplexing. Not only that, but one author uses the same letter in several different senses in one of his works.

How would, say, chemistry get along, if every man had his own system of notation?

T. Crichton Fulton.

December 18*th*, 1888.

The Comparison of Thermo and Magnetic Lines.

I have been trying to demonstrate that heat and magnetic lines act upon molecules in the same direction, and, with the evidences of the ordinary magnetic, electric, and thermo effects, I think I shall succeed. But if any of your correspondents can throw out any suggestions, from their knowledge or experience, it may, perhaps, prevent me going over a lot of unnecessary ground.

I am distinctly told that magnetic lines run longitudinally in an electro-magnetic core, and that the crystallisation in ordinary iron castings is normal to the surfaces of cooling; so that from the former we may safely say that magnetic lines act at right angles to an electric current, and *vice versa*; and, from the latter, that heat lines, passing from a hot to a colder body, govern the direction the crystals will take up, and its rapidity the size of the crystals and their cohesion. For instance, take a quantity of molten iron, and place it in a cylindrical mould whose conductivity is nil except at the ends, at which points good conductors of heat are placed, the crystals of the iron will be found to be arranged longitudinally, in the direction of the coolers, and from the interior where the heat was longest getting away, to the exterior where it was quickest, so the size (inversely as the rate of cooling) of the crystals. If the cylinder mould be placed vertically, and resting upon a good conductor, and the other conductor be plunged in above, and under hydraulic pressure, we have a more regular crystallisation.

In the case of experiments with sulphur, I have already obtained remarkable results from various rates and directions of cooling. From an experiment where the temperature was allowed to fall from the melting point to normal temperatures, extending over a period of a month, I obtained crystals which would not, actually, hold together when unsupported; by reversing the operation, and by a very complete arrangement for regular and quick cooling, a substance is produced as hard as concrete, but the poor conducting properties of sulphur prevents the operation being done upon a large scale.

Reverting back to the iron—if, under the influence of magnetic lines it arranges its crystals longitudinally, and heat effects the same result, what is the difference? In the case of magnetism, it may only be a strain, a degree of what is produced by heat.

We have some light when considering an iron or other metal wire carrying an electric current: if the wire be heated to bright redness by the current, and that suddenly stopped, and at the same time disconnected from any good heat conductors with which it may be in contact, and this alternate heating and cooling be repeated a few times, the iron becomes rotten; its crystalline condition has become quite altered.

With these facts, may we not conclude that heat lines cut by a closed conductor will generate a current, as well as by cutting magnetic lines?

Use, say, an ordinary coil, as employed in the investigations on the B.A. units (but without unnecessary heat conductors beyond the wire), and rotate so that the coils cut heat lines passing from a hot to a cooler body, the heat in the one and the cooling properties in the other being maintained; air convection, too, must be considered.

James J. Richardson.